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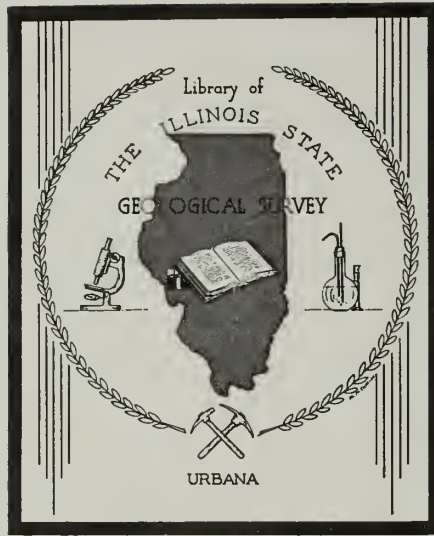
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Illinois State Geological Survey Annual Report

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**Illinois Department of Energy and Natural Resources
STATE GEOLOGICAL SURVEY DIVISION**

ANNUAL REPORT

**to the
BOARD OF NATURAL RESOURCES
AND CONSERVATION**

May 1, 1984 to April 30, 1985



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CONTENTS

HIGHLIGHTS	vii
MINERAL RESOURCES PROGRAM	3
ILLINOIS MINERAL INDUSTRY IN 1983 AND 1984	3
MINERAL RESOURCES RESEARCH AND SERVICE	5
COAL	5
Coal Research and Service Program	5
Coal Resources and Geology	6
Composition of Coal	9
COAL ANALYSIS	13
COAL DESULFURIZATION AND COAL CLEANING	17
Other Coal Research and Service	25
OIL AND GAS	25
Economic Trends and Outlook	25
Oil and Gas Program for Illinois	27
Petroleum Geology Investigations	29
Source Rock and Migration Studies	30
Composition of Natural Gas	31
BIOGEOCHEMISTRY	32
Oil and Gas Statistics	33
Other Service Activities	33
INDUSTRIAL MINERALS	34
Industry News	34
Limestone and Dolomite	34
Sand and Gravel	35
Fluorspar, Lead, and Zinc	36
Clay	36
Silica and Industrial Sand	38
Other Industrial and Strategic Minerals Activities	38
Service Activities in Industrial Minerals	39
MINERAL ECONOMICS	39
Projects	39
Service Activities	41
GEOLOGICAL RECORDS UNIT	41
Data Acquisition	42
Computer Project	43
Service Activities Summary	43

GEOLOGICAL SAMPLES LIBRARY	45
General	45
Cuttings	45
Cores	46
Other Sample Collections	46
Supplies	46
Summary of Service Activities	46
Other Projects	47
ENVIRONMENTAL GEOLOGY PROGRAM	50
ENVIRONMENTAL STUDIES AND ASSESSMENT	50
Illinois Lands Unsuitable for Mining Program (LUMP)	50
Long-Term Ecological Research (LTER)	51
GEOLOGY FOR PLANNING	53
Fermilab	53
Other Projects	55
WASTE MANAGEMENT	55
Landfills/Septic Systems/Groundwater Contamination	55
Coal Wastes	56
Hazardous Toxic Wastes	57
Low-Level Radioactive Wastes	61
Service Activities Related to the Hydrogeology of Waste Disposal	63
GEOLOGICAL STUDIES OF ILLINOIS LAKES AND RIVERS	63
Lake Michigan Research and Service	63
Rivers and Back-Water Lake Research	66
Erosion	67
HYDROGEOLOGY INVESTIGATIONS	67
Groundwater Geology	69
Groundwater Geochemistry	70
Groundwater-Geophysics Studies	71
Service Activities	71
Other Studies and Projects	72
EARTH HAZARDS AND ENGINEERING GEOLOGY	72
Landslides	72
Earthquakes	73
Mine Subsidence Activities	73
GENERAL AND BASIC RESEARCH	78
GEOLOGIC MAPPING	78
Surficial Geology	78
Bedrock Mapping	79
Topographic Mapping and Cartographic Information	80

GEOPHYSICAL INVESTIGATIONS	81
Gravity-Magnetic Investigation	81
Isotope Geochemistry	81
CLAY MINERALOGY	83
Remote Sensing Activities	84
STRATIGRAPHIC INVESTIGATIONS	84
Quaternary Stratigraphy	84
1985 Friends of the Pleistocene Field Trip Guidebook	87
Paleozoic Stratigraphy	89
Subsurface Geology	91
STRUCTURAL GEOLOGY	93
PALEONTOLOGY/PALYNOLOGY	95
Palynological Studies	95
Macropaleontology	98
Micropaleontology	98
COMPUTER RESEARCH AND SERVICES	99
Service Activities	99
ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES	102
PUBLICATIONS, GRAPHICS, AND PHOTOGRAPHY UNIT	102
Survey Publications Completed May 1984 through April 1985	103
Graphics and Typesetting	106
Survey Publications in Preparation	107
Reproductions	107
INFORMATION AND TECHNICAL SERVICES UNIT	109
Information Office	109
Mail Room	110
WORD PROCESSING CENTER	111
TECHNICAL RECORDS OFFICE	111
TECHNICAL DESIGN, OPERATIONS AND MAINTENANCE	111
Electronics Shop	113
Automotive	115
LIBRARY	116
Operations	116
Other Activities	117
EDUCATIONAL EXTENSION AND PUBLIC RELATIONS	119
RECOGNITION AND SERVICE	124

COMMUNICATING WITH INDUSTRY, GOVERNMENT, AND THE PUBLIC	124
HONORS AND AWARDS	125
PAPERS AND ABSTRACTS IN NON-SURVEY PUBLICATIONS	126
SCIENTIFIC AND EDUCATIONAL CONTRIBUTIONS	139
Professional Societies	139
Conferences and Field Trips	144
Teaching, Lectures, and Seminars	150
Poster Sessions and Educational Exhibits	151
Workshops/Training	152
Public Addresses	153
Radio, TV, Press Interviews/Presentations	153
Governmental Committees	154
Governmental Testimony/Presentations	154
Service on Industrial Committees	158
Public Service	158
GEOLOGICAL SURVEY ACTIVITY MEASURES	161
Background	161
Measures	161

1984 HIGHLIGHTS

MINERAL RESOURCES

- The total value of fuel and nonfuel mineral resources produced in Illinois exceeded \$3 billion in 1984. The Illinois Geological Survey continues to provide information, ideas and technology useful to industry in their exploration and wise development of these resources.

COAL

- A new set of statewide maps in color, including five Coal Resource maps and a Coal Industry map was issued. For the first time, comprehensive information on Illinois' coal resources is available in one set of statewide maps. The resource maps, scale 1:500,000, show thickness, depth, and tonnage by area of all known coal resources (both deep and surface minable) in 32 coal seams in Illinois. The industry map shows mined-out areas, location, type, and production of active mines, and locates major coal-burning power plants and coal-handling docks along rivers and Lake Michigan.
- The national debate on the reduction of SO_2 output by coal-burning utilities of the Midwest clouds the outlook for Illinois coal, but provides an incentive for research and development on economical ways of removing sulfur from coal.
- Efforts continued to locate low-sulfur coal reserves through subsurface and surface mapping, the former in central Illinois and the latter in southern Illinois.
- A major multidisciplinary program has been undertaken at the Illinois State Geological Survey on coal desulfurization and coal cleaning. About 35 scientists, engineers and support staff are directly involved. The ISGS is coordinating its efforts with five other member institutions--Argonne National Laboratories, Northwestern University, Southern Illinois University (Carbondale), University of Illinois (Urbana-Champaign) and the University of Illinois (Chicago)--which together make up the Center for Research on Sulfur in Coal (CRSC). The wide-ranging program at the ISGS involves fine-coal cleaning and chemical coal cleaning investigations.
- Major improvements were made in the analytical capabilities to carry out the desulfurization work at the ISGS. The Thermal Analysis Laboratory was computerized; a Fischer assay unit was installed to measure the probable yield of products from low-temperature carbonization of coal and oil shale; a new Leco SC-32 Sulfur determinator was installed with capabilities of analyzing total sulfur in about

two minutes; improved analytical techniques were developed for analyzing chlorine and sodium in coal; and efforts were increased to improve the efficiency of the facilities used in analyzing coal.

- A microscopic procedure was developed that provides a pyrite cleanability index (PCI). The index shows that there is an increasing potential for removing pyritic sulfur as finer and finer crushed samples are used. The index also shows promise as a measure of the washability of coals.
- A new fine-coal cleaning process is being developed and tested. It involves microbubble flotation of very fine-size coal particles which have been pre-conditioned with kerosene to make the particles hydrophobic. Separation of ash and pyrite from the coal is achieved by mixing a stabilized microbubble emulsion with the pre-conditioned coal. Recent batch runs have reduced the ash from 39% to 5% and pyritic sulfur from 2% to 0.4% while 72% of the combustible material remained in the product.
- Other processes for removing sulfur from coal are being investigated. Low-temperature charring, to which our initial desulfurization efforts were directed, is being combined with other methods including fluidized-bed pyrolysis of coal and oil shale, microbial treatment, oxidative desulfurization and/or dehydrogenation. These investigations have opened up new possibilities for achieving a solid compliance fuel. Also burning characteristics of char have been investigated indicating that the rate of combustion is satisfactory for utility boilers.
- An innovative method, desulfurization of coal by production of an in-situ catalyst, is currently being studied in collaboration with scientists at Southern Illinois University. A three-step process under development involves: (1) reduction of pyrite and marcasite by carbon monoxide to troilite, (2) conversion and removal of organic sulfur catalytically with ethanol, and (3) removal of the remaining iron sulfide, the spent catalyst. Flowing gas conditions, which remove sulfur products (carbonyl sulfide, H_2S , and volatile organic sulfides), are most important to the success of this process. Sulfur percentages are reduced in this process sequence to less than 0.7% sulfur. Several of the coals thus treated are in compliance with the federal emission guidelines of less than 1.2 pounds of SO_2 per million BTU's and 90% reduction in sulfur based on run-of-mine coal.
- Two economic studies of low-temperature charring support the conclusion that pyrolysis of Illinois coal could provide an economically sound approach to coal utilization.
- Leaching experiments have been conducted for the removal of chlorine, a corrosive boiler element, and sodium, a boiler fouling element, from Illinois coals. Up to 100 percent of the chlorine and 85 percent of the Na in coal can be dissolved in water through a process involving heating, soaking, and multiple leaching of coal samples ground to 325 mesh size. It was found that the sodium and chlorine

occur mainly as adsorbed ions on the coaly matter and clay minerals and as dissolved ions in pore water, and hence are extractable by washing solutions.

- A computerized information system on the chemistry of Illinois coals has been established which will make chemical data available to investigators throughout the state via remote terminals.
- An economic study of surface mining equipment suggests that overcapacity of mining equipment exists in Illinois. If measures could successfully be taken to reduce the overcapacity, significant cost savings could be affected that might give Illinois an edge in coal markets.

OIL

- Useful models have been developed to explore for petroleum-bearing Aux Vases sand bodies. These offshore sandbars occur as stratigraphic traps. X-ray diffraction and scanning electron microprobe analysis of the Aux Vases petroleum reservoirs have shown that clay minerals are the probable cause of poor well completions and lowered well productivities from this formation. Completion practices are needed that mitigate the impact of these clay minerals.
- Work is underway on a network of lithologic cross sections across the Illinois Basin. These sections will provide a framework for identifying and understanding the multiple oil plays in the basin.
- A source-rock study sponsored by nine major oil companies has been nearly completed. The study, based on visual identification of organic matter and vitrinite reflectance, has delineated the major source rocks for hydrocarbons and their degree of maturation throughout the Illinois Basin.
- Within the past year, 33 gas and gas/oil wells were treated to determine gas flow rates. This testing service is the only one of its kind in the state. As a result of the ISGS testing and consultation, natural gas which would have been flared or shut-in is now being used. Of special note has been the testing of five wells in the area of a new gas field in Pike County, southeast of the old Pittsfield Gas Field, near the town of Time.
- A Rock-Eval unit has been acquired providing the Survey with additional capabilities to screen the Illinois Basin for source rocks and to evaluate them chemically.
- The distinct carbon isotope value found in sedimentary biogenic methane can be explained by the action of methanogenic bacteria. Experiments have shown that isotopic fractionation occurs during microbial activity. The magnitude of this fractionation is in agreement with widely observed data that shows biogenic methane is much more depleted in carbon-13 than is thermogenic methane.

INDUSTRIAL MINERALS

- A directory of sand and gravel and stone producers in Illinois was published this past year.
- Computerization for storage and retrieval of information on Illinois' clays and shales is underway. This is critical to the future definition of clay resources. The file grows by 1,000-3,000 samples per year.
- To meet the demand for information on the strength of various rock materials, the Survey has embarked on a program of testing quarry samples for point load, tensile, and sonic velocities. Activities of the rock mechanics lab continued at a high level.
- The feasibility of marketing kaolin clay as a waste by-product of silica sand is being investigated. Air-floc flotation, a process developed at the ISGS to upgrade fine-grained materials, was used to separate fine-grained quartz from clay in the tailings of a sand washing plant. A marked increase in recovery was noted over the established froth flotation method.
- As a part of a USGS Midcontinent Strategic and Critical Minerals Program, the Illinois State Geological Survey compiled specific data sets including: (1) a structure map on top of the Precambrian basement, (2) a map showing the location of basement and other deep holes in Illinois, (3) five cross-sections showing the major stratigraphic sequences, (4) a thickness and facies map of the upper Sauk sequence, and (5) a mineralization distribution map.

GEOLOGICAL RECORDS

- A Survey-run copying system, implemented in June 1984, has significantly streamlined operations and increased the security and accessibility of the geological records data base.

GEOLOGICAL SAMPLES

- There was a 52% increase in the number of times that visitors and staff members used our sample files at the Geological Annex. This included some 178 visitors who visited us on 296 occasions.
- A core index file has been completed identifying all cores on file at the Survey's Sample Library.

COMPUTER RESEARCH SERVICES

- The ILLIMAP computer file of section and township coordinates is being corrected for use on the Prime 750 computer.

- As a part of the Lands Unsuitable for Mining Program (LUMP), numerous maps have been digitized and automated and added to the Geographic Information System (GIS).

LONG TERM ECOLOGICAL RESEARCH (LTER)

- A manual has been compiled describing 50 LTER Field and laboratory procedures associated with this projected 30-year study. The manual is designed to be used as documentation of LTER methods and to provide coordination of laboratory and field techniques among the four agencies involved in this project over five widely separated areas.

SUPERCONDUCTING SUPER COLLIDER (SSC)

- A geological study involving the compilation of available data and the drilling of nine test holes has shown the area in the vicinity of the present Fermilab Tevatron ring to be suitable geologically for siting the SSC, a potential 4 to 6 billion dollar federal project. The area is stable seismically and the bedrock conditions within the Plattville-Galena dolomite section are ideal for tunneling. The tunnel, in which the SSC accelerator ring is to be located, is about 10 feet in diameter. It will be in the shape of a ring some 20 to 30 miles in diameter, 60 to 100 miles in circumference. Preliminary plans suggest that the tunnel will be located about 400 feet underground.
- The Illinois State Geological Survey is working jointly with the Natural History Survey, the State Museum, and the State Water Survey to screen the area near the existing Fermilab facility, Batavia, Illinois. Screening is needed to ensure that no fatal flaws exist that will jeopardize the selection of the SSC ring site. Preliminary studies, already completed, concluded that environmentally sound sites for the SSC ring could be found west of Fermilab.
- The three Scientific Surveys and the State Museum combined with DENR to issue a report on the SSC to the Governor and the General Assembly in early 1985. The report concludes that the SSC can be built in a safe, sound, secure, stable area.

WASTE MANAGEMENT

- The Geological Survey joined with the other two Scientific Surveys, the State Museum and DENR's Springfield office this past year to form a Hazardous Waste Research and Information Center (HWRIC). The reduction and safe disposal of these wastes requires a multidisciplined approach.
- As a part of the HWRIC program, the Survey is conducting a statewide landfill inventory of all known disposal sites in Illinois recording their hydrogeologic setting and waste sources. This is in preparation for prioritizing sites that may require further monitoring.

- Additionally, as a part of the State's program on hazardous wastes, the Survey is studying current practices of injecting hazardous wastes underground to determine if underground injection is an appropriate method of disposal. This is a project mandated through Senate Bill 1954 and House Bill 3176. A report summarizing the findings of this study is to be prepared by July 1st for the Governor's Office and the General Assembly.
- Several tasks related to groundwater were mandated by the General Assembly during the 1983 and 1984 legislation sessions. These were assigned to the Illinois State Geological Survey and to the State Water Survey. The three programs in which the ISGS is involved included:
 - 1) Special studies related to groundwater quality especially in the vicinity of hazardous waste facilities. The extent of groundwater contamination is to be determined, and recommendations for implementing an effective groundwater quality protection plan are to be developed.
 - 2) Services associated with the Water Use Act of 1983. This act will require ISGS participation in evaluating the impact of high-capacity well sites in Illinois or groundwater supplies.
 - 3) Development of an Aquifer Assessment Plan for Illinois that addresses the needs for an integrated program for groundwater resource assessment.
- Effects of surfactants on the solubility and sorption of PCBs by earth materials have been studied in a series of laboratory experiments. The results indicate that to prevent migration of PCBs from a landfill, they and anionic surfactants should not be disposed of in the same landfill area. The presence of anionic surfactants in solution greatly increases the solubility of PCBs and decreases their sorption. Increased mobility of PCBs results.
- A simple and rapid procedure has been developed for measuring the relative potential of earth materials to remove chemical pollutants from contaminated water. Adsorption curves can be constructed to estimate the amount or concentration of a chemical pollutant that will be adsorbed by an earth material. The method is being developed as a standard ASTM procedure.
- A detailed hydrogeological and chemical study has revealed an explanation as to why organic contaminants were migrating 100 to 1,000 times faster than predicted in a hazardous waste facility. Local groundwater flow and gradient are dominated by a 45-foot high coal mine refuse pile that causes radial flow from the pile through the disposal trenches. The flow of contaminants occurred through joints or partings in natural materials that were not detected or simulated in small laboratory specimens of "undisturbed" or recompacted soils. The distribution of contaminants at the disposal facility is clearly related to the patterns of groundwater flow.

- Working with the Department of Nuclear Safety, ISGS scientists are establishing criteria to be used in siting a low-level radioactive waste disposal facility. Factors such as presence of aquifers, population density, or area of natural resource concentration are being mapped on a statewide scale using the Geographic Information System (GIS).

ILLINOIS LAKES AND RIVERS

- Increasing attention is being given to research and service related to elevated Lake Michigan lake levels and the rapidly accelerating rate of shore damage and instability. Record lake levels are predicted for mid-year 1986 and ISGS activities are expected to accelerate accordingly.
- Survey staff have provided information essential to the new construction and planning for the lake shore of Lake Michigan including the development of harbors at Zion-Winthrop and at Lake Forrest. In addition, maps and data have been contributed to the planning effort for harbor changes related to the proposed 1992 Chicago World's Fair at Burnham Harbor.
- Radiometric techniques developed at the Survey are being used to measure sedimentation rates of Illinois' lakes and pools. Dates range from 3.6 cm/year above Lock and Dam 19 on the Mississippi River to 0.1 cm/year in Lake Michigan. Two radioisotopes, Cs 137 and Pb 210, have been used. Results indicate that the radiometric techniques can measure sedimentation rates more quickly than conventional surveying techniques and may replace or supplement these conventional methods.

HYDROGEOLOGY

- Hydrogeological and geophysical investigations of groundwater resources in Kane County have identified a municipal-sized, shallow groundwater resource located within the corporate boundary of Aurora on land owned by the city. Test holes, drilled subsequent to a seismic refraction and electrical earth resistivity exploration program, have proved the prediction of groundwater supplies based on these two geophysical methods.

GEOLOGICAL HAZARDS AND ENGINEERING GEOLOGY

- A brochure entitled "Earthquakes in the Illinois Area" was prepared by ISGS staff members and published by the Illinois Emergency Services and Disaster Agency for distribution as a part of a series dealing with the hazards of earthquakes in Illinois.
- Data collected by the Survey in the analysis of insurance claims related to mine subsidence are proving useful in establishing other causes of foundation damage. The data base is growing on where

Illinois soils are susceptible to shrinking and swelling, where unstable slope conditions exist, and where compressible organic materials or poorly compacted foundation materials are located.

GEOLOGIC MAPPING

- The USGS is providing significant support for basic ISGS geologic mapping in southern Illinois. Work is underway in a 14-quadrangle area across the southern closure of the Illinois Basin. In the Creal Springs quadrangle, detailed mapping has already revealed more extensive coal resources than were previously known. Renewed interest by smaller mining companies is expected as a result of these renewed efforts to map in detail the mineral resources in this area.

GEOPHYSICAL INVESTIGATIONS

- A successful ground magnetic survey was conducted at a hazardous and chemical waste disposal site near Wilsonville to locate and define the boundaries of buried disposal trenches.

STRATIGRAPHIC INVESTIGATIONS

- Major advances were made in determining the stratigraphic succession of Quaternary units in northern and northeastern Illinois. A number of these new findings will be reviewed with other scientists during the 1985 Friends of the Pleistocene Field Trip.
- Similarly, the stratigraphy of bedrock units was also advanced in a series of studies of both local and regional scope. New relationships of upward coarsening sequences within the Ordovician Maquoketa shale were noted in northeastern Illinois. In Ordovician carbonates, two petroleum bentonites have been traced, on the basis of trace element chemistry, for a distance of 800 kilometers. And elsewhere, facies relationships within the Carboniferous Fraileys shale and Haney limestone units demonstrate that the central part of the Illinois Basin was the site of deposition of deeper water carbonates and distal clastic facies while shallow water carbonates and near-shore clastics occur along the edge of the basin on structural shelves. Transitions between shallow and deeper water carbonates correspond with major structural features in the Basin that appear to have been broad hinge lines separating shallow shelf areas from deeper offshore areas.

STRUCTURAL GEOLOGY

- A map of the Precambrian surface was completed on a scale of 1:500,000. Local topographic relief of more than 800 feet is indicated on this surface. Phanerozoic rocks are shown to on-lap these topographic highs.

- The Survey's research on the nature of the complex geologic structure of southern Illinois continued at a high level supported in part by the U.S. Nuclear Regulatory Commission. A report was compiled on the extent, nature, age, and origin of faults and related structures in this area. Most faults in the region reflect late Paleozoic and Mesozoic reactivation of faults of a Precambrian-Cambrian rift system--the Reelfoot Rift and the Rough Creek Grabens. The ENE-WSW modern compressive stress region does not appear to be related to these ancient fault systems. Rather the modern ENE-WSW region is believed to be responsible for jointing, minor thrust faulting, ground failure in underground mines, and small-to-moderate earthquakes that occur in the area.
- A study of the St. Genevieve fault zone shows that it was developed by two movements--one in late Middle Devonian time and the other in late Mississippian through early Pennsylvanian time. Faults were produced by vertical uplift and tilting of basement blocks.

PALYNOLOGY/PALEONTOLOGY

- A paper based on palynology and coal-ball studies is the most extensive compilation available on the paleoecological information on Pennsylvanian coal swamp floras in North America. The paper includes the first palynological correlation between the Illinois Basin and eastern Kentucky coals. It illustrates the major and sudden change in coal swamp floras at the Desmoinesian-Missourian boundary in North America and the Westphalian-Stephanian boundary of Europe.
- Also, a publication was prepared showing the major time-stratigraphic boundaries of the Upper Carboniferous and how correlations exist between the Midcontinent series (our Midwest correlation), the European Series, the divisions of the Soviet Union, and those used by the USGS. This will help to establish the relationships between the numerous standard reference systems.
- Advances were also made in acquiring new knowledge of conodonts and how they may be used in correlating stratigraphic intervals.

OTHER SCIENTIFIC PROGRAMS

- At the end of the reporting period, the Illinois State Geological Survey was also developing two new exciting programs--a superdeep hole (30,000 feet) in southern Illinois to provide scientific information in this critical mid-continent region and a deep crustal geophysics program (COCORP) to provide deep seismic profile data on the nature and configuration of the deep crust and its overlying section of sedimentary rocks.

ADMINISTRATIVE SERVICES

- A marked increase was recorded in the number of Survey reports and papers released for publication. Additionally, the Survey partici-

pated with the other two Scientific Surveys in the first ever, new, three Surveys report series--the Illinois Scientific Surveys Joint Report.

- A continuous well log copying service was introduced together with a telephone order service for well log copies.
- NBI wordprocessing work stations increased from 4 to 7 helping the Survey to reach new levels of efficiency and speed in providing reports and information to the public, industry, institutions, and government agencies.
- Heroic services were provided by the Technical Design, Operation, and Maintenance Group in designing, fabricating, wiring, and installing equipment and in providing more efficient work space. They also assisted in setting up an Inter-Survey Geotechnical Laboratory.
- The Geological Library implemented major efforts to computerize its operations especially in producing catalog cards. It began searching IRN, an online computerized data base of research and scholarly interests, as well as monitoring LIS through computers.
- The Educational and Public Relation Unit issued a new attractive booklet "Educational Resources" listing services and educational materials available and suitable for primary and secondary school levels.

ACTIVITY MEASURES

- Sharp increases were recorded in the number of reports/maps written, especially in Mineral Resources and Environmental Geology.
- Also sharp increases occurred in demands for information (phone inquiries, visitors, and letter inquiries) for Environmental Geology as concerns for Illinois' environment continued to grow.

MINERAL RESOURCES RESEARCH AND SERVICE



The Bridgeport Quarry is one of a number of quarries in the Chicago area being studied by ISGS geologists in an attempt to ensure future sources of construction aggregate. Current supplies are becoming depleted, and urban sprawl is encroaching on potential quarry sites in the area.

Mineral production data for 1983 and 1984.

Commodity	Unit	1983		1984		Percentage of change from 1983 to 1984	
		Quantity	Value (thousand \$)	Quantity	Value (thousand \$)	Quantity	Value
MINERAL MATERIALS MINED							
Fuels							
Coal	thousand tons	58,374	\$1,714,432	66,158	1,918,600 ^a	+ 11.5	+ 11.9
Crude oil	thousand bbl	29,200	849,137	28,870	808,400 ^a	- 1.1	- 4.8
Natural gas	thousand Mcf	1,030	2,926	1,546	4,282 ^a	+ 50.1	+ 46.6
Industrial and construction materials							
Stone	thousand tons	42,763	166,931	45,100	172,000	+ 5.5	+ 3.0
Sand and gravel	thousand tons	25,160	101,271	25,630	109,940	+ 1.9	+ 8.6
Clays ^b	thousand tons	717	3,360	251	1,018	- 65.0	- 69.7
Fluorspar	thousand tons	W	W	W	W	+ 14.0	+ 18.8
Tripoli	thousand tons	W	W	W	W	+ 0.2	- 14.7
Metals							
Lead	tons	W	W	W	W	- 0.6	+ 14.6
Zinc	tons	W	W	W	W	+138.9	+176.9
Silver	troy ounce	W	W	W	W	- 0.5	- 4.3
Other							
Peat	thousand tons	W	W	W	W	+ 2.6	+ 0.8
Gem stones		NA	15	--	15	--	--
Barite, primary	thousand tons	W	W	W	W	+ 33.3	+ 51.0
Values that cannot be disclosed (W)							
		-	27,471		32,556	--	+ 18.5
Total value of mineral materials mined							
			\$2,865,543		3,046,796		+ 6.3

^a Estimated by ISGS

^b Excludes fuller's earth; included with value of items indicated by symbol W.

W = Withheld to avoid disclosing individual company confidential data.

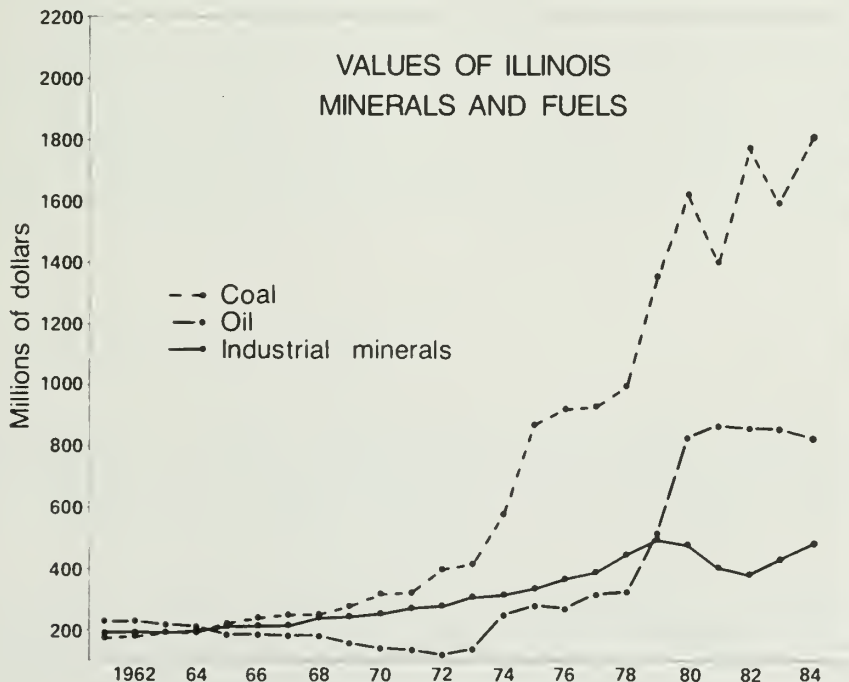
MINERAL RESOURCES PROGRAM

ILLINOIS MINERAL INDUSTRY IN 1983 AND 1984

In 1983, the total value of Illinois mineral production in current dollars was about \$2.87 billion, roughly 6 percent lower than in 1982. In constant dollars the decline was approximately 10 percent. This decline in value was largely attributable to a decrease in coal production in 1983, unaccompanied by a corresponding increase in per ton price of coal. Another contributing factor was the decline in total value of oil production in 1983; although oil production increased 5.4 percent over 1982 (reaching a 10-year high), the decrease in oil prices more than offset increased production.

Preliminary figures for 1984 (these are estimates) indicate that the value of 1984 mineral production in Illinois increased 6.3 percent in current dollars (about 2% in constant dollars). The total value for 1984 is estimated to have exceeded the \$3 billion mark. Preliminary data suggest that Illinois coal production (66 million tons of coal mined) may be the highest since 1945, and indications are that coal prices have remained nearly unchanged for the third year in a row. Stone production was up 5.5 percent in 1984, indicating a revival in the construction industry after the recession.

The value of mineral materials processed and mineral products manufactured in Illinois in 1984 is estimated to have increased, apparently because of overall improvements in the economy. The total value of mined, processed, and manufactured products may reach the 1981 high of approximately \$3.8 billion.



Fuels account for more than 90 percent of the value of Illinois mineral production--therefore, energy-related state legislation can significantly affect the economics of the extraction and use of state minerals. Several amendments passed during 1984 may have implications for the mineral industry:

- Utilities that purchase high-cost gas (from Algeria, for instance) can no longer pass this cost on to their customers by raising utility rates (PA83-0950); this may stimulate the use of Illinois gas.
- Pollution control costs can now be considered in determining utility rates if the utility uses Illinois coal (PA83-0249); this should improve the competitive advantage of Illinois coal.
- State funds have been set aside to provide financial assistance for projects related to research and commercial development of Illinois coal resources; DENR will administer these funds (PA83-1024).
- The motor fuel tax on gasohol has been reduced from 7.5 to 3.5 cents per gallon, but special low sales tax rates on gasohol have been removed (PA83-9050).

MINERAL RESOURCES RESEARCH AND SERVICE

Mineral resources contribute significantly to the economy of Illinois. Mineral research and service at the ISGS is designed to provide incentives for the mineral industry to explore and develop these Illinois resources: new data may point to regions where previously unsuspected resources could be present, suggest new exploration strategies, or lead to unconventional ways of extracting, processing, and using mineral resources. Mineral resources in Illinois include coal, oil and gas, and industrial minerals--limestone, dolomite, sand and gravel, fluorite, lead, and zinc.

Survey scientists are continuing to focus on developing efficient, low-cost methods of removing sulfur from high-sulfur Illinois coal to increase its marketability and use; ways are also being sought to remove sodium and chlorine (which cause corrosion and other problems in boilers) from Illinois coals. Continued basic and applied research on the deleterious, as well as the potentially valuable, minor constituents of coal, are imperative, given the low level of national effort in this field and its importance to the Illinois economy.

Oil and gas production from the Illinois Basin (as from other U.S. basins) is characteristically episodic: a new idea, a new play, a new and deeper field, or a significant advance in the technology for tertiary oil recovery could significantly alter the historical production curve for Illinois. This episodic history suggests that production in Illinois could again increase significantly.

Sand, gravel, and stone account for more than 88.9 percent of Illinois industrial mineral production; the construction industry is the largest consumer of these materials. As reserves at existing quarries become depleted and urban sprawl encroaches on potential quarry sites in large metropolitan areas, the search for new sources of crushed stone for construction of roads and buildings becomes urgent. Survey scientists are playing a major role in this search, identifying sources of construction aggregate, evaluating their quality, and investigating the feasibility of underground mining to ensure future supplies.

COAL

Coal Research and Service Program

The goal of the Survey's program of coal research and service is to provide reliable, current information on the state's vast coal resources to industry, government, and private citizens to promote the development and wise use of this valuable resource.

ISGS coal studies during the reporting year focused on coal resource identification, quantification, and characterization, and on the properties of rocks associated with mined coal seams that may influence minability and subsidence after mining. Studies of the occurrence,

nature, and removability of sulfur and chlorine in coal have high priority, since these elements hinder the development of Illinois coal. The Survey's research projects related to the study of sulfur and other noxious elements in coal are supported by the Illinois Coal Research Board and coordinated through the Center for Research on Sulfur in Coal (CRSC).

Activities of the Coal Mining Industry in Illinois (Damberger, Bhagwat, and Wells). The national trend for some of the large oil and gas companies to divest themselves of coal companies and reserves they acquired during the cash-rich period following the "energy crises" of 1973 and 1979 is apparent in Illinois. Houston Natural Gas Company sold the four operating mines of its Zeigler Coal Company subsidiary to senior mine management (HNG had acquired Zeigler in 1973). Insufficient return on investments is the commonly cited cause for industry reorientations. As the economy improves, new companies may take advantage of coal reserves for sale or lease.

Black Beauty Coal Company, a medium-sized independent coal company that operates three surface mines in Indiana, announced plans to open a surface mine in Schuyler County, near Camden, western Illinois, on an 11,000-acre site. The Colchester (No. 2) Coal is the target.

Recently incorporated Energy Resources Development Company of Chicago has acquired leases in east-central Illinois and announced plans to open a new underground mine near Oakland in northeastern Coles County. Exploratory drilling is in progress.

Drilling activity decreased significantly over that of the previous year, as measured by the plugging affidavits filed with the Department of Mines and Minerals and the Illinois State Geological Survey (1504 versus 3804). Most of this drilling activity is related to active surface mines; however, some drilling took place in relatively unexplored areas.

The national demand for coal increased significantly in 1984, and this trend also was noticeable in Illinois (66.6 million tons estimated production in 1984 versus 57.7 million tons in the previous year). When the coal miners' strike did not materialize, demand and production fell significantly. No substantial new coal markets are visible in the immediate future. The national environmental debate on the reduction of SO₂ output by coal-burning utilities of the Midwest clouds the outlook for Illinois coal, but provides a strong incentive for research and development addressing the removal of sulfur from coal.

Coal Resources and Geology

Coal Exploration Records (Morgan and others). Coal Section staff have described and recorded about 1,850 feet of drill core obtained from 15 drill holes from eight counties in Illinois. Approximately 50 drillers logs, 40 geophysical logs, and 40 chemical analyses from coal

companies in six counties in Illinois were received and filed, along with 140 drillers' logs from the Illinois Basin coal field outside Illinois. These logs are valuable for regional comparisons.

Companies known to be actively drilling include Ark Land, Consolidation Coal, Exxon, Inland Steel Coal, Kerr-McGee, Midland Coal, Old Ben, Peabody Coal, Sahara Coal, Shell Mining, Shot Point Services, Turris Coal and Zeigler Coal.

Coal Resource Maps (Treworgy and Bargh). For the first time, comprehensive information on Illinois coal resources is available in one set of statewide maps; previously, numerous publications had to be consulted to obtain this information. The five multicolor resource maps (scale 1:500,000) show thickness, depth, and tonnage by area of all known coal resources (deep and surface minable) in 32 coal seams in Illinois. The maps were released in October 1984 and are much in demand by the coal industry, government agencies, and citizens of Illinois. Their publication was made possible through significant financial support by the member companies of the Illinois Coal Association and the U.S. Bureau of Land Management.

Coal Industry of Illinois Map (Damberger, Bhagwat, Treworgy, Berggren, Bargh, and Sampson). A statewide color map (scale 1:500,000) displaying data on the coal industry of Illinois was published simultaneously with the coal resource maps. This map shows areas mined out; location, type, and production of active mines; and locations of major coal-burning power plants and coal-handling docks along rivers and Lake Michigan. The project was partly funded by the U.S. Bureau of Land Management and the Illinois Coal Association. The map has been well received by industry and governmental agencies as a reference item and is expected to be of significant value as an educational tool for the public.

Coal Resource Data on Federal Lands in Illinois (Treworgy and Bargh). At the request of the U.S. Bureau of Land Management, and with their support, ISGS staff compiled coal resource information for 67 7.5-minute quadrangle maps that include federal lands. These maps and accompanying tabulations are now available to the public; they can be inspected in the ISGS Map Room or purchased at cost as mylar overlays. The formats developed during this project will be used for future systematic compilations. Contract/Grant Report 1984-1 provides additional information on this project.

Coal Resources of La Salle, Livingston and Grundy Counties, Illinois (Jacobson). This study resulted in an increase of the known coal resources for the three-county area. The study identified previously unmapped areas of minable Danville (No. 7) Coal, upping estimates by 920 million tons (more than 70%); the study also resulted in increases in the resource estimates for the Houchin Creek (No. 4) and Herrin (No. 6) Coals. Reductions of nearly 30 percent were made in resource estimates for the Colchester (No. 2) Coal, which was found to be of variable thickness. The distribution and thickness of all the coals in the

report area are significantly related to geological structures; the thickest deposits are restricted to the synclinal troughs of the La Salle Anticlinal Belt, which extends north-south through the eastern part of the Illinois coal field. This study, to be summarized in Circular 536, will help locate thick coal deposits along the La Salle Anticlinal Belt.

The Dekoven and Davis Coals in Southeastern Illinois--Initiative for Establishing a Computerized Coal Resources Work Station (Jacobson). This study was prompted by evidence from a previous study demonstrating that the Dekoven and Davis Coals in southeastern Illinois are equivalent to the Seelyville Coal in eastern and central Illinois, and thus are of potential economic interest over a large unmapped area of southeastern Illinois. To date, drill hole data have been compiled on computer forms for one of the 21 counties under study. These data will eventually be added to the Survey's Basic Well Data File.

The Dekoven and Davis Coal resource study will serve as a pilot study for the establishment of a microcomputer work station with a portable digitizer. Funding will be sought from the U.S. Geological Survey Coal Branch to set up this work station. An interactive coal resource evaluation package will be developed.

Geology of Herrin (No. 6) Coal in Central Illinois (Christian, Macoupin, Montgomery and Sangamon Counties) (Nelson). This is one of a planned sequence of investigations of the low- to medium-sulfur coal resources (containing less than about 2.5% sulfur) of Illinois. Such coal deposits are of considerable economic interest. A first draft of a report covering distribution, thickness, depth, structure of the coal and the geology and mining conditions of the Hornsby District at the center of the study area is complete. Of the approximately 12 1/2 billion tons of coal in place almost 1.2 billion tons is low/medium-sulfur coal (this estimate is based on geologic interpretations, not sampling and analysis of coal cores). Mining of this low/medium-sulfur coal has been deterred to date by fear of bad roof conditions, but the roof in this area is probably no less stable than that in other areas of Illinois where coal has been mined successfully for many decades.

Fulton County Structure (Trask). Coal structure maps are in great demand by companies and individuals seeking coal, oil, and gas. Many oil fields are controlled by the geologic structure of an area, yet no modern structure maps are currently available for most of Western Illinois, where shallow oil discoveries have sparked local developments. A series of county structure maps is planned for Western Illinois. Data collection for the Fulton County map is half completed. Datum points are spaced at half-mile intervals, providing more structural detail than any previous coal structure map for this part of the state. This map should stimulate drilling for oil and gas in new, unexplored areas and facilitate future coal exploration.

Building a Data Base on the Strengths of Illinois Rocks (Fox and Bauer). Demand for information about the strength of various rock materials continued at a high level: thousands of point load, tensile, and sonic tests were conducted during the year (the emphasis shifted somewhat from rocks associated with coal seams to quarry tests). Six hundred sample sets taken from stone quarries throughout Illinois were tested for strength and sonic velocities in cooperation with the Caterpillar Tractor Company, which requested this information for its machinery development program.

Researchers of Sandia National Laboratory received information on the strength of limestones and dolomites of the Dunleith and Wise Lake Formations of northern Illinois. Atlas Powder Company and Sandia are investigating the explosive properties of jointed rock and the performance of explosives.

Requests to evaluate mine plans for subsidence potential were received from the Indiana Division of Reclamation, DuPont, the Universal Mining Company in Indiana, Exxon, several consulting companies in Illinois and Iowa, the Illinois Department of Mines and Minerals, and several Illinois coal mining companies.

Composition of Coal

Composition and Distribution of Macerals in Illinois Coal (Harvey). This work is part of an important long-term program to evaluate organic constituents of coals (macerals) and their effects on coal quality. Microscopical methods are required to identify macerals and evaluate their properties. Analytical results for more than 325 channel samples from 98 locations have revealed useful regional patterns of compositional variation. A report entitled "Macerel Distributions in Illinois Coals and Their Paleoenvironmental Implications," which describes these patterns and their use in predicting maceral contents in unexplored areas of the state, will appear in the International Journal of Coal Geology.

Information System on Chemistry of Illinois Coals (ISCIC) (Harvey, Kar, Bargh, and Kohlenberger). The Illinois coal Research Board, through the CRSC, has funded a project to establish a computerized data base of standardized (ASTM) chemical analyses on samples of coal in ISGS files and to design retrieval software. The ISCIC data and software have been developed and are being tested. The interactive system allows users outside the ISGS and the University of Illinois to gain access and transfer selected data to their computers. Users will be charged a nominal fee in accordance with Natural Resources Information Fund (NRIF) rules. A proposal to extend the studies to include all special samples in the Illinois Basin Coal Sample Program has been submitted to the Illinois Coal Research Board.

The Quality of Illinois Coals: Data Management of Chemical, Mineralogical and Petrographic Properties and Geological Assessment of Coal Beds in the Illinois Basin (Harvey and Steele). A proposal to design a comprehensive computerized information system on coal quality and install it on one of the computer systems available on the UI campus has been submitted to the U.S. Geological Survey. The data base will include standardized (ASTM) analyses, minor and trace elements, mineral matter, and petrographic analyses on geologically described samples. The data will also be reformatted and transferred to the National Coal Resources Data System managed by the U.S. Geological Survey.

These projects will provide a comprehensive information system on Illinois coal available to researchers, industry, and government agencies and greatly reduce time-consuming searches of diverse publications and paper files.

Characterization and Removal of Sodium and Chlorine from Illinois Coals (C.-L. Chou, Demir, Cahill, Chaven, Winston, and Sotomayor). Objectives of this project, funded by the Illinois Coal Research Board, are to investigate the distribution and chemical forms of sodium (Na) and chlorine (Cl) in the organic and inorganic components of coal (lithotypes, macerals, and minerals). A better understanding of how these elements are bound in the coal can lead to development of more effective techniques of removing these corrosive, boiler-fouling elements from Illinois coals before combustion.

During the past year, samples from two coal mines in southern Illinois were collected and separated into their lithologic components (lithotypes). An electron microprobe was used to determine sodium and chlorine in the microscopic organic components of coal (macerals). Studies of hand-picked coal lithotypes show that chlorine is more concentrated in the organic components (lithotypes) than in the inorganic (mineral) components. Sodium is less concentrated in the organics but may be associated with both clay minerals and organic matter. Chlorine is thus more difficult to remove than sodium because of its greater association with organic components. Sodium associated with clay minerals can be cleaned from the coal by washing. Electron microprobe results reveal that organically associated sodium and chlorine exhibit a positive correlation with each other, possibly because of salt water in coal micropores.

Leaching experiments were conducted on samples of whole-coal and prepared size fractions of Herrin coal to determine how various physical and chemical conditions affected washabilities of chlorine and sodium in coal. Results indicate that heating, soaking, and multiple leaching are the most effective means of leaching Na and Cl from the samples: up to 100 percent of the Cl and 85 percent of the Na in coal samples ground to -325 mesh size can be dissolved in water.

Sodium, Chlorine, and Trace Elements in Illinois Coal: Influence of Shale Partings on Their Variability Within a Mine (C.-L. Chou, Winston, Cahill, and Chaven). Three channel samples and a run-of-mine

sample from a mine located in Jefferson County were collected to study the effect of shale partings on the quality of the Herrin Coal. These samples, plus shale parting samples and six hand-picked lithotype separates, were analyzed for Cl, Na, and 30 other elements. Lithotype separates were analyzed for maceral compositions. The ash contents in channel samples are 7.6, 10.5, and 33.4 percent, respectively. Shale partings were present in the samples with the highest ash content. The amount of Na and Cl found in different channel samples depended on the amount of shale partings they contained; shale parting has a higher Na and lower Cl content than the coal, so an increase in shale content of the sample decreases the concentration of Cl and increases that of Na in the samples. Many trace elements are enriched in the high ash samples because of their association with clay minerals in the shale partings.

Determination of Soluble Species in Coal by Ion Chromatography (Demir, Chaven, and C.-L. Chou). Many constituents of coal are soluble in water and other solvents. The soluble species significantly alter the chemistry of leachates during coal washing processes, and changes in the chemical compositions of leachates could in turn affect the removal of impurities such as Na, Cl, and S, in coal. With support from the Illinois Coal Research Board, an ion chromatograph was purchased to monitor the chemistry of leachates from coal cleaning processes used to remove Na, Cl, S and trace elements from Illinois coals.

Reduction Potential of Sulfur, Sodium, Chlorine, and Trace Elements in Illinois Basin Coals by Washability Tests (C.-L. Chou, Cahill, Steele, and Demir). High-sulfur coal from the Illinois Basin is washed primarily to reduce its ash and sulfur contents. Many minor and trace elements present in raw coal are also reduced by washing because they are mixed, compounded, or bound with the grains of major minerals (pyrite, sphalerite, calcite, clay minerals, and quartz). Sodium and chlorine occur mainly as adsorbed ions on the coaly matter and clay minerals and as dissolved ions in pore water, and hence are extracted by washing solutions.

In this study chemical and mineralogical data on four sets of washability tests were reviewed to further evaluate the reduction potential of sulfur, ash, and trace elements in Illinois coal. Washability characteristics of the elements depend on their affinities to organic and mineral matter and on the degree of liberation of minerals by grinding and sieving. Elements associated with sulfide minerals and calcite are significantly depleted in washed coal, but elements associated with clay minerals are only moderately depleted because a portion of the clay is finely dispersed in coal and cannot be separated by the method used. This work has been submitted for presentation at the 10th International Coal Preparation Congress, Edmonton, Alberta, Canada.

Geochemistry of a Pennsylvanian Black Shale in the Illinois Basin: Anna Shale Member of the Carbondale Formation (C.-L. Chou, Cahill, and DeMaris). Coal seams in the Illinois Basin are commonly overlain by black shale, which may be a potential oil shale resource that could become a useful by-product of coal mining. A review of compositional

data on 13 samples of the Anna Shale Member, which overlies the Herrin (No. 6) Coal, showed that the samples are remarkably enriched in organic C, S, P, V, Ni, Zn, Se, Mo, Cd, and U as compared with nonmarine shales. This indicates that the Anna Shale was deposited in an epicontinental sea formed by marine transgression over the peat swamp. Upwelling of phosphate-rich, oxygen-poor water facilitated the accumulation of organic matter and the formation of sulfides and phosphates, as well as coprecipitation of certain trace elements from marine water. Analyses indicate that lithophilic elements are positively correlated to each other as a result of their association with clay minerals. Petrographic studies of separated kerogens (dispersed organic matter) from the Anna Shale suggest that an appreciable portion of the organic matter was derived from terrigenous plant material, indicating that it may be a potential source rock for natural gas.

Study results were presented at the 1984 Eastern Oil Shale Symposium, Lexington, Kentucky.

Chemical Characterization of Desulfurization Products from Coal (M. M. Chou and Griffin). A gas chromatograph equipped with a flame photometric detector specific for sulfur compound characterization was used to study the thermal decomposition of coal, pyrite, and coal macerals during flash pyrolysis. A systematic characterization was carried out through analysis of the volatile compounds produced during pyroprobe pyrolysis to determine the chemical nature of the sulfur species in coal. These data will be used to develop improved methods to characterize the structure of organic sulfur in coal.

Determination of Pyrite, Marcasite, and Pyrrhotite in Coals and Chars (Hughes and Cowin, with Shiley et al., Coleman et al., and Ruch et al.). X-ray diffraction methods are especially helpful as a confirmation of analytical techniques that measure forms of sulfur in coal and coal-related products. Certain iron sulfides (marcasite in coal and pyrrhotite in chars and cokes) are soluble in hydrochloric acid; pyrite (FeS_2) is not. The common method for determining pyritic sulfur is based on the assumption that sulfur is insoluble in HCl. Significant deviations from this assumption result in errors not only in determining pyritic sulfur but also other forms of sulfur. In the past year, the ISGS has developed a new method that utilizes XRD data to reinterpret pyritic sulfur determinations made by conventional analysis and thus achieve a higher degree of accuracy. The method includes mass balance calculations that further aid in the investigation of sulfur removal. This research has resulted in five talks and two submitted publications in the past year.

Mineralogy of Clay Partings in Illinois Coals (Hughes, DeMaris, White, and Cowin). The investigation of clays and shales associated with Illinois coals continues at a steady pace. A publication now in preparation summarizes the origin and distribution of these materials. Results show that underclays and partings in coals were soils prior to compaction and burial, but that most of the soil formation in underclays resulted from plant growth before the establishment of the coal-forming

swamp. Some underclays and most of the shales overlying coalbeds are relatively unaltered deposits of detrital debris. Underclay composition is probably related to contemporaneous channel location, much like low-sulfur coal and nonmarine roof shale, which are also associated with the channels.

COAL ANALYSIS

The Chemical Group has a strong analytical component geared to perform the many determinations required to evaluate the composition of coal and support basic and engineering coal research. Efforts are being made to increase the Survey's analytical capabilities and to cope with the ever-increasing demand for new kinds of computer-controlled analyses.

Illinois Basin Coal Sample Program (Kruse, Rapp, and Stephenson). In 1982, the Illinois Coal Research Board (ICRB) expressed interest in funding a project to collect and store reasonably large quantities of coal to be used as standard samples for future analyses. The board desired to ensure that a few of the coals currently used by ICRB contractors be available for future work. At the request of ICRB, the Geological Survey collected additional quantities of the coals used by the first-year contractors who had been awarded funds through the Center for Research on Sulfur in Coal. This has now become the Illinois Basin Coal Sample Program (IBCSP).

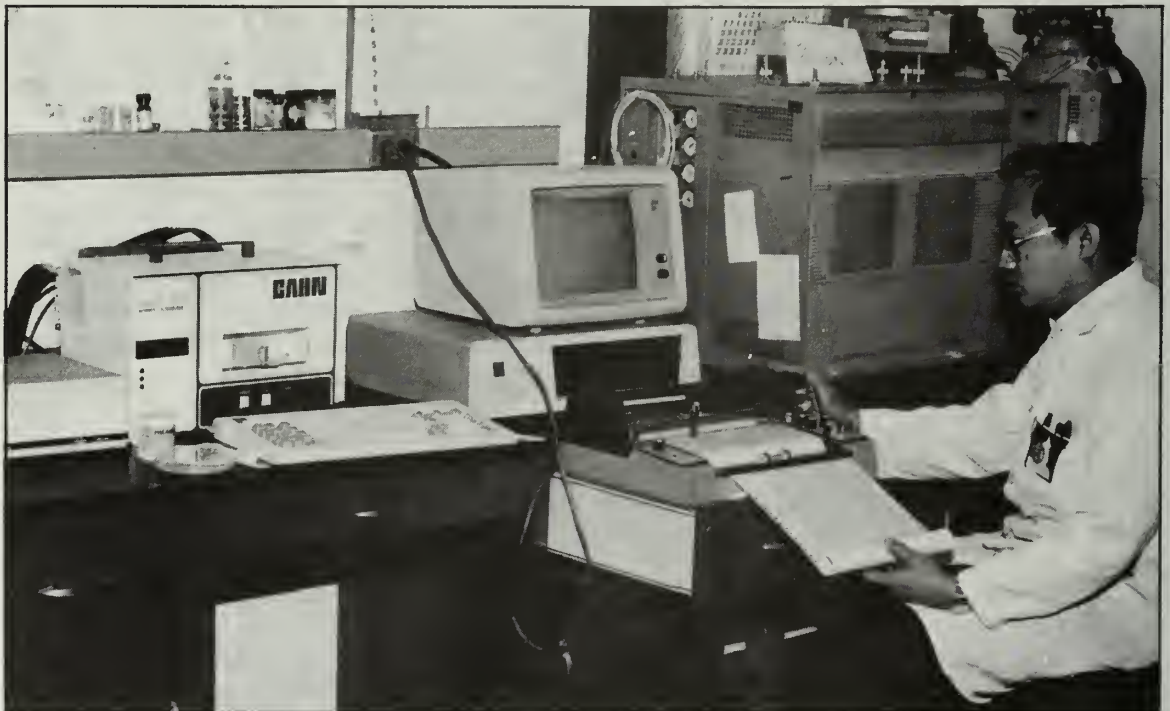
Three mine-washed coals and one tippable coal--the base coals for the program--were transported to the ISGS Applied Research Laboratory, where they were crushed, screened, riffled, and placed in modified 55-gallon barrels. The barrels were then purged of air, sealed, and pressurized with nitrogen.

The sizes of samples made available to sample users are normally in the 0.5- to 10-kilogram (1- to 20-pound) range. During 1984 more than 1,600 pounds of coal was distributed through the program. Each sample dispensed is given a unique seven-digit number. Records are kept of the requesters receiving samples, their location, and the type of research planned.

The ISGS received funding from the ICRB for the first of two additional years' work on this program. In addition to required storage rearrangement and expansion, channel samples of two additional Illinois coals will be obtained in cooperation with Argonne National Laboratory (ANL), one in 1985, the second in 1986. These will be processed by ANL in its special inert atmosphere facility into the 5-gram and 20-gram hermetically sealed ampoules and into 1-pound, 10-pound, and 40-pound cans. The ampoules will be retained for ANL's Premium Coal Sample Program and the cans will be brought to the ISGS for storage and distribution in the IBCSP.



Chen-Lin Chou, Coal Section, checks data from the new Dionex 2000 ion chromatograph for a study investigating the chemistry of leachates from processes used to remove chlorine and sodium from Illinois coals.



Chusak Chaven, Minerals Engineering, examines output from Elemental Analyzer connected to a microcomputer. This instrument is used to determine carbon, nitrogen, hydrogen, and sulfur in coal.

Thermal Analysis Laboratory (Rostam-Abadi, Chaven, Kruse, and Kwan). Computerization of the Thermal Analysis Laboratory (ThAL) in the ISGS Applied Research Laboratory (ARL) has been completed. Several instruments (thermal gravimetric analysis, differential thermal analysis, differential scanning calorimetry, elemental analyzer, and an electronic electrobalance) were interfaced to IBM personal computers and special-purpose, menu-driven software programs were developed for data collection and storage. Other programs were developed for data analysis, plotting, and data file management. The performance of the computerized instruments has been demonstrated to be accurate and precise.

The personal computers in the ThAL are currently being interfaced to University of Illinois computer systems to transfer data files to the main-frame computers. This arrangement will facilitate the use of many of the special-purpose, sub-routine packages, vital to data analysis and interpretation, that are available on the main-frames.

A Fischer assay unit has been installed to predict the probable yield of products from low-temperature carbonization of coal and oil shale. The Fischer Assay retort can decompose coal samples into measured amounts of char, tar, water, light oil, and gas. This information can be used to predict to some degree the effectiveness of the ISGS fluidized-bed reactor for processing coal and oil shale samples. The unit will benefit other research groups wishing to characterize coal samples.

Coal Analysis Laboratory (Kohlenberger, Chaven, Kuykendall, McMillion). In the past year, the Coal Analysis Laboratory has performed approximately 3,500 individual analyses on more than 700 samples--about double the output of the previous year. The largest sample load came from the ICR-funded Fine Coal Cleaning Project. The large increase in requests for analyses necessitated the addition of one more full-time assistant to the laboratory staff. To distribute the costs of these analytical services equitably and efficiently among the various users, a service account was established through the University of Illinois Contracts Office.

The new Leco SC-32 Sulfur Determinator, in use since August 1984, provides total sulfur values in about 2 minutes instead of the 2 days often required by the previous methods. This instrument provides accurate results when testing samples for which standard reference materials are readily available for instrument calibration. But because reference materials are lacking for high-sulfur materials (>10%), calibration is not as precise and results are less accurate for high-sulfur materials. For certain materials, such as shales, a catalyst must be used in order to completely release all of the sulfur present. Evaluation of the effectiveness of the instrument for determining total sulfur in other types of materials is in progress.

Changes in the data handling system have greatly improved the efficiency of obtaining analytical reports. Computer files for each request are created by Computer Section personnel in the Natural Resources

Building, transferred to the U of I Cyber computer, and completed by the addition of Coal Laboratory data in the Applied Research Laboratory. Final reports are then printed, checked, and distributed. Recent changes made in the data entry program have also speeded data processing. Dr. Harvey has spearheaded the establishment of a computerized information system that will make the data available to investigators throughout the state via remote terminals.

Coal Analysis Laboratory staff participate in monthly and semi-annual round robins conducted by Standard Laboratories and Amax Coal Corporation. New analytical methods being investigated by Dr. Chaven would add additional varieties of sulfur to the three forms now determined in ASTM D-2492. A new Dionex 2000, Ion Chromatograph has been purchased on contract to facilitate investigation of sodium and chlorine in coal.

Coal Analysis Laboratory Instrument Automation and Method Development (Chaven, Rostam-Abadi, and Kwan). The IBM-PC and Keithley DAS computer-controlled data acquisition system for operating the CAHN balance has been completed. Sample weights that were formerly recorded manually can now be stored in a diskette and merged with software for total automatic operation of the Erba Elemental Analyzer. The Orion digital pH/mV meter, the Dionex Ion Chromatograph, and the Leco Total



Elticia McMillion, Minerals Engineering, operates new Leco Sulfur Determinator, which provides total sulfur values in about 2 minutes instead of the two days required by previous methods.

Sulfur Analyzer now used in the Coal Laboratory will benefit from this computer-controlled data acquisition system.

Organic-bound chlorine in coal has been studied in conjunction with the Coal Section. Coal samples were pyrolyzed at different temperatures under an inert atmosphere to study the release of HCl gas. The chlorine gas absorbed in an alkaline solution during pyrolysis was estimated by the total chlorine method used to determine chlorine in coal. Analytical methods of identifying sulfur forms in both coal and chars are also being studied. Estimation of sulfur in the form of sulfide in coal can now be made potentiometrically using a AgS solid membrane electrode. The same electrode is also employed in chlorine determination, permitting determinations of Cl and S simultaneously for the same sample. This method is useful when both Cl and S are evolved during pyrolysis studies.

Applied Research Laboratory Machine Shop (Jimmie Cooper). In the last working year, 75 percent of the machine shop staff's time was spent on contract work involving the basic installation and maintenance of equipment: choosing efficient parts for equipment; designing and constructing project parts from scratch; revamping old equipment into functioning working parts; and installing and updating equipment.

The shop was involved in four major projects: thermogravimetric analysis, fine coal cleaning, uniform coal sample bank, and fluidized bed reactor. For the fluidized bed project the shop staff designed and built a hood to house the unit and a rack to hold it and all related equipment. Electricity, gas, and air were provided in order for the hood to function.

The staff was also concerned with the general management and maintenance of building functions and inventory and evaluation of equipment, including research on the efficiency of equipment and the construction, installation, and replacement of equipment to increase efficiency and safety. As a part of this effort, office partitions were installed in the central office area.

COAL DESULFURIZATION AND COAL CLEANING

ISGS Coal Desulfurization Program (During the past several years, coal desulfurization and cleaning investigations have evolved into a major program at the Survey, directly involving at least five Sections and one Unit (about 35 scientists, engineers, and support staff). Through the Center for Research on Sulfur in Coal, ISGS desulfurization research is being coordinated with research at other institutions throughout the state to a much higher degree than ever before.

ISGS desulfurization research has developed into an integrated program investigating a number of different approaches to desulfurization. One approach is to attempt to reduce or control the pyrite content of a feed coal before combustion. Research on fine-coal cleaning with a new

ISGS process called aggregate flotation has been very successful. Another strategy, combining low-temperature charring (the focus of initial ISGS desulfurization efforts) with other methods--including fluidized-bed pyrolysis of coal and oil shale, microbial treatment, oxidative desulfurization, and dehydrogenation--has opened up new possibilities for achieving a solid compliance fuel.

A promising new method, desulfurization of coal by production of an in-situ catalyst from pyrite, is currently being studied. As in low-temperature charring, a partially desulfurized solid fuel (with liquids) is produced, which upon further treatment can yield a solid compliance fuel. The use of Illinois mineral and agricultural products (oil, shale, ethanol, and corn and soybean oils) in the development of coal cleaning and desulfurization is being vigorously pursued.

Development of the ISGS Aggregate Flotation Fine-Coal Cleaning Process (Buckentin, Rapp, Camp, Ruch, Steele, and Kohlenberger). With support from the Illinois Coal Research Board, a new fine-coal cleaning process is being developed and tested. Basically it involves floating very fine-sized coal particles (<325 mesh, f 45) in micro air bubbles under special reagent and operating conditions so that the desirable components stick to the surfaces of the bubbles and float, and impurities separate out and sink. The process requires that coal be pre-conditioned with kerosene prior to separation. Separation is achieved by mixing a stabilized microbubble emulsion with the pre-conditioned coal. Subsequently, flotation/settling is assisted by further agitation with larger "booster" bubbles.

Separation performance is improved when the process is run in multiple stages. Recent batch runs on a high-sulfur, high-ash Illinois coal have been encouraging: ash was reduced from 39 percent to 5 percent and pyritic sulfur from 2 percent to 0.4 percent, while 72 percent of the combustible material remained in the product. Unlike other methods, the process is relatively successful on coal that contains finely disseminated pyrite. Extensive chemical and petrographic data have been generated and are being evaluated. More Illinois coals of differing chemical and petrographic composition will be tested.

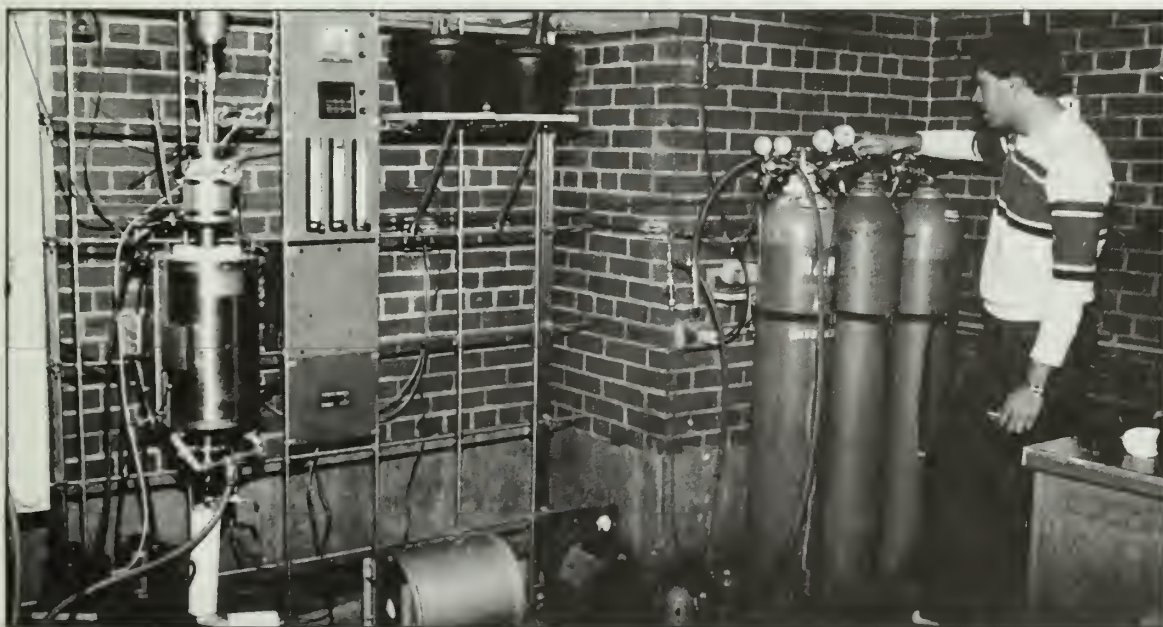
A continuous flow plant capable of processing up to 100 pounds of coal at a time is being fabricated and will be tested soon. Several coals will be tested and the data obtained from the operation will be used to evaluate the economics of the process.

Fine-Coal Cleaning with Illinois-Produced Vegetable Oils (Ruch, Camp, and Buckentin). Preliminary experimental work has been done at the ISGS on substituting soybean oil or corn oil for hydrocarbon collectors (petroleum-based products) used in various fine-coal cleaning processes. The results are promising. Comparable pyrite and ash rejection can be obtained when vegetable oils (corn and soybean oils) are used instead of kerosene in the aggregate flotation process.

A proposal seeking partial funding for further work in this area has been submitted to the American Soybean Association. Use of these vegetable oils in commercial fine-coal cleaning circuits would increase the demand for the agriculturally produced oils and reduce the demand for petroleum-based solvents. Preliminary economics appear favorable.

Development of Fluidized-bed Pyrolyzers for Producing Desulfurized Coal Char (Stephenson, Rostam-Abadi, Cooper, and Kruse). In a two-step desulfurization process currently under development, high-sulfur coal is partially desulfurized by charring and the resulting char is then further desulfurized by other means. Char is more amenable to desulfurization than are Illinois coking coals because it can be treated at temperatures above 400°C (coking coals agglomerate or stick at these temperatures). Pyrolysis and char desulfurization processes are efficiently carried out in fluidized bed reactors because both processes involve reactions between gas and solids. Fluidization converts a bed of solid particles into an expanded, suspended mass that resembles a boiling liquid. The excellent mixing in fluidized beds and the concomitant increase in mass and heat transfer rates make fluidized beds ideal reactors in which to study both processes.

A reactor system has been designed, built, and installed to study pyrolysis and char desulfurization simultaneously. The central unit, a batch, 2-inch I.D., bench-scale reactor, has been tested. The rate of heating and the rate of cooling of this reactor can be precisely controlled. For isothermal runs, solids can be introduced into the hot reactor by a pressurized system. A gas inlet system facilitates metering of various gases and a preheater raises the temperature of the fluidizing gas to the desired inlet temperature. The off-gas is cooled,



Pyrolysis and char desulfurization processes can be studied simultaneously in this fluidized bed reactor in operation at the Applied Research Laboratory. Mike Stephenson, Minerals Engineering, monitors equipment.

and the condensable volatile components are collected using a two-stage dry ice bath. The noncondensable gases are vented to a fume hood. Future plans call for interfacing the system to an IBM personal computer for rapid data acquisition.

Thermogravimetric Studies of Co-pyrolysis of Coal and Oil Shale (Rostam-Abadi and Kruse). Data on the devolatilization behavior of coal are essential for determining process parameters of operation, scale up, and economic analysis of the fluidized bed reactor presently in operation at the ISGS Applied Research Laboratory. The thermogravimetric approach was used to evaluate effective kinetic expressions for the pyrolysis of the three mine-washed coals in the Illinois Basin Coal Sample Program. The data were interpreted by a non-isothermal method of kinetic analysis using a power-law kinetic model. This model was inadequate for describing the devolatilization behavior at temperatures above 475°C. A kinetic model that incorporates a large number of reactions has been developed and is currently being tested. Preliminary results are encouraging. This model is also being tested for its adequacy in determining desulfurization kinetics of coal during low-temperature carbonization.

Thermogravimetric data have also been obtained for thermal decomposition of Illinois oil shale samples. Special attention has been given to the thermal behavior of carbonate minerals in the oil shales. The presence of these minerals in oil shale makes this abundant Illinois resource an ideal sulfur scavenger. An investigation of the possibility of pyrolyzing coal and oil shale together to produce compliance char is underway at the Survey.

Hydrogen Sulfide Acceptor Studies of Oil Shales (L. Johnson and Rostam-Abadi). Carbonate minerals in oil shale should capture significant portions of the hydrogen sulfide evolved when coal and oil shale are pyrolyzed together. This interaction is expected to enhance the desulfurization of char during pyrolysis or hydrodesulfurization. Thermodynamic data from a literature study revealed that at temperatures below 600°C the theoretical concentration of hydrogen sulfide in equilibrium with these minerals approaches zero; this suggests that these minerals should be efficient sorbents. In terms of the dynamics of the pyrolysis reactor, the rate of absorption of hydrogen sulfide was also found to be adequate. However, successful use of the minerals as sorbents will depend on the rate of reaction of hydrogen sulfide with coal char (an undesirable competing reaction).

Hydrodesulfurization of Coal Char (L. Johnson, Albal, and Kruse). Because partially desulfurized char from most pyrolysis reactors still contains too much sulfur to be burned as a compliance fuel, hydrodesulfurization is being studied as a method of removing the remaining sulfur from char. Char produced in a rotary tube charring oven was first washed with hydrochloric acid to remove calcium and iron minerals that limit the level to which desulfurization can be carried. The optimum temperature for hydrodesulfurization is about 800°C. A compliance char can be produced by this laboratory method, but the cost of char by a commercial process involving an acid wash step is probably too costly to be seriously considered.

Low-temperature Charring of Coal: Application of Natural Isotope Variations to the Desulfurization of Illinois Coal (Liu, Hackley, Coleman, and Hawk). Knowledge of the variations of naturally occurring ratios of sulfur isotopes ($^{34}\text{S}/^{32}\text{S}$) in coal can be used to accurately monitor the release of pyritic and organic sulfur forms during thermal desulfurization of Illinois coal. This discovery is important because it allows optimization of desulfurization conditions for each of the two major sulfur forms in coal. For example, when low-temperature coal char is partially oxidized, stable isotope tracer experiments show that pyritic sulfur is preferentially removed. Up to 70 percent of the total sulfur is volatilized. Subsequent hydrogenation of partially oxidized chars removed additional amounts of sulfur--up to 97 percent of the total. In the latter case, isotopic data show that both organic and pyritic sulfur are removed, while the residual sulfur in the char is organic. The weight loss of the char after hydrogenation ranged between 44 and 53 percent, part of which can be recovered as condensed liquids.

An integrated study of the chemical and mineralogical behavior of sulfur in coal during the pyrolytic and partial oxidation thermal phase is underway. Several of the controlling parameters (i.e., temperature, heating rate, particle size, coal rank, sulfur forms) are being varied during charring/partial oxidation experiments to determine the optimum conditions for sulfur removal. Results obtained from this research may enhance our understanding of the mechanisms and properties that control desulfurization.

Desulfurization of Illinois Coal by In-Situ Preparation of Iron Sulfide Catalysts (Shiley, Hughes, Lapish, Cowin, and Webster (ISGS); G. V. Smith, C. C. Hinckley, and M. Saporoschenko (SIU-C)). Recently, significant gains have been achieved in coal desulfurization using iron sulfides as in situ catalysts. The process produces desulfurized chars on a laboratory scale which meet federal emission standards. In the first process step, carbon monoxide, CO , is reacted with coal at about 350°C and 300 psi. Pyrite in the coal converts by this to a catalytic troilite (FeS)/ troilite "B" ($\text{Fe}_{16}\text{S}_{17}$) mixture and produces carbonyl sulfide (a valuable commercial product). In the second step, the troilite/troilite "B" mixture catalyzes ethanol desulfurization of organic sulfur. The third step in the process removes the catalyst. Current research for step 3 uses oxidation to convert the catalyst to a magnetic pyrrhotite (which can be removed), or to SO_2 gas. The table gives the results of several coals treated with steps 1 and 2. An acid wash has been used to remove the catalyst as a substitute for step 3.

It is an especially important aspect of this process that pyrite and marcasite are transformed in step 1 to a troilite/troilite "B" mixture without the production of elemental sulfur, which is formed when pyrite and marcasite are thermally decomposed. Using a flowing gas reactor, carbonyl sulfide and hydrogen sulfide from the transformation of pyrite and marcasite are carried out of the system. This removal prevents resulfurization of the char, which we have identified as the central problem in pyrolytic desulfurization.

Step 2 makes use of the reactivity of ethanol with the catalyst to effect the removal of organic sulfur. Hydrogen produced on the iron sulfide surface by dehydrogenation of the ethanol combines with organically-bound sulfur to form hydrogen sulfide. Simultaneously, sulfur is returned to the catalyst to form lower-iron-content pyrrhotites, such as hexagonal pyrrhotite ($\text{Fe}_{11}\text{S}_{12}$). In these systems, inorganic sulfur, organic sulfur, and hydrogen sulfide form a complex equilibrium which is exploited to remove organic sulfur from the coal matrix. When flowing-gas conditions are simulated by repeated exchanges of autoclave gases, the composition of the iron sulfide moves toward troilite, FeS . We have also shown that some pyrrhotites will desulfurize thiols, and that thiophenic sulfur can only be removed over troilite--not pyrite, marcasite, or other pyrrhotites. Rapid and continuous sulfur removal afforded by flowing conditions favors the formation of troilite, and therefore, the liberation of thiophenic sulfur.

Desulfurization of Illinois Coals^a

Location	Coal Seam No.	Wt. % pyritic sulfur	Wt. % organic sulfur	Wt. % total sulfur ^b	Wt. % total sulfur in product
Northwestern	2	1.33	0.96	2.71	0.39
West central	6	1.18	2.71	4.21	0.60
West central (prep plant)	6	1.21	2.89	4.37	0.42
Southwestern	6	1.37	2.08	3.56	0.45
Southwestern	6	0.63	1.79	2.50	0.47
Southwestern	5	1.22	2.11	3.47	0.52
South central	6	0.38	0.50	0.89	0.37
Southeastern (prep plant)	5	1.41	1.71	3.15 ^c	0.66

^aNo. 2 is the Colchester (No. 2) Coal, No. 5 is the Springfield (No. 5), and No. 6 is the Herrin (No. 6) Coal. The samples were collected as fresh material at the mine and stored under argon, but are not considered representative of the mine product.

^bTotal sulfur includes unlisted sulfate-sulfur.

^cRaw coal sulfur concentrations: pyritic = 3.91%, organic = 1.25%, total = 5.35%.

Chemical Methods for Char Desulfurization (Griffin and M. Chou). In this study, sulfur forms in volatile matter produced during pyrolysis and hydropyrolysis were measured as a function of pyrolysis temperature. Reactions of char components with hydrogen in hydropyrolysis resulted in a much higher concentration of thiophenic organics than occurred during pyrolysis in a nitrogen atmosphere. This study improved the understanding of how sulfur is retained in coal char and what types of sulfur reactions are involved in its removal during acid leaching and hydro-pyrolysis processes. The knowledge obtained is essential for development of efficient desulfurization processes based on coal pyrolysis and production of char.

Utilization of Organic Sulfur Compounds by Sulfolobus Sulfotaricus and Solfolobus Acidocaldarius (Risatti). Recent reports suggest that the acid loving, heat loving archaeobacterium Solfolobus acidocaldarius



Patty Lapisch and John Webster, Geochemistry, are crushing and grinding coal samples in a nitrogen atmosphere (to prevent oxidation) in a study of desulfurization using sulfides as in-situ catalysts.

is able to solublize coal organic sulfur compounds and also oxidize dibenzothiophene, a sulfur organic compound that occurs in coal. These studies have not determined if the organism utilizes organic sulfur compounds for cell carbon or solely as an energy source while growing autotrophically. Products of the reaction and the degradation pathway have also not been determined.

The rates of organic sulfur degradation by sulfolobus, the products formed in the reaction, and the possibility that carbon from organic sulfur compounds is used for cell growth will be investigated. These experiments will also be performed with another archaeobacterium, Sulfolobus sulfotaricus, to ascertain if these reactions are specific to S. acidocaldarius.

Size and Maceral Association of Sulfide Grains in Illinois Coals and Washed Coal Products (Harvey and DeMaris). A microscopic procedure for determining the size and maceral association of sulfide grains was developed, tested, and applied to three sets of washed (float-sink) samples. The procedure provides a pyrite cleanability index (PCI), a numerical value of potential use for predicting the amount of pyritic sulfur that can be removed from a given coal by washing. The project was funded in part by the Illinois Coal Research Board through the CRSC. The final report is nearing completion.

Petrographic and Mineralogic Investigations of the Potential for Cleaning Fine Coal (DeMaris, Harvey, and Hughes). The project objectives are (1) to perform petrographic and mineralogic analyses on feed coal samples used in cleaning experiments, on cleaned and on refuse materials, and (2) to evaluate the influence of the predominantly physical petrographic and mineralogic characteristics on the various processes undergoing optimization. Results have tended to confirm the utility of the pyrite cleanability index (PCI). Tests on a set of samples progressively crushed to finer sizes gave correspondingly higher PCI values, indicating an increasing potential for sulfur removal (as sulfide) as the grains become finer. A proposal was submitted for continued funding of this project through CRSC.

Combustion Reactivity of Char from Allis Chalmers' Pilot Test (Rostam-Abadi, R. Frost, and Kruse). Determinations were made of the oxidation reactivity and specific surface area of a char, made from Illinois coal, from Allis Chalmers' Pilot test facilities in Milwaukee, Wisconsin. The results were compared to combustion reactivities of chars from four commercially-significant coals of different rank from various areas of the state. BET surface area measurement showed that the pores in the char were predominantly micropores. Burn-off curves were calculated from isothermal thermogravimetry (TG) data at 700°C and in one atmosphere of air pressure. The char was completely burned in 6 minutes. This rate compares well with those of chars, made in commercial processes, which have been shown to have satisfactory burning characteristics for utility boilers. Results indicate that sulfur content, not burning characteristics, is the major problem on which to focus attention in developing a commercially attractive char process.

Other Coal Research and Service

Coal Section staff members devote a significant amount of time to answering requests for information on Illinois coals and associated rocks. Requests come from farmers, home owners, small coal operators, large coal companies, utilities, industrial coal users, and government agencies. The requests concern mined out areas and subsidence possibly related to these mines, current mining (i.e., roof conditions in mines and acid-forming capacity of rock types), future coal development potential, and the possible impact of such development on the economy and environment. Responses during the reporting year were as follows:

Telephone requests	973
Letter reports	637
Office conferences/visitors	321
Field conferences and meetings	34
Public addresses	9
Press interviews	7
Government/Court testimony	1

Technical Briefing for Northern Indiana Public Service (Harvey, Damberger, Chou, Bhagwat, Shimp, Steele, Wells, Liu, Hackley, Risatti, Kruse, Ruch, Buckentin, Stephenson, and Rostam-Abadi). ISGS staff gave four combustion engineers and chemists from Northern Indiana Public Service Company a 2-day technical briefing on the geological, mining, and chemical aspects of coal for use at utility plants. Microscopical and x-ray diffraction analyses were performed on samples provided by the utility company.

OIL AND GAS

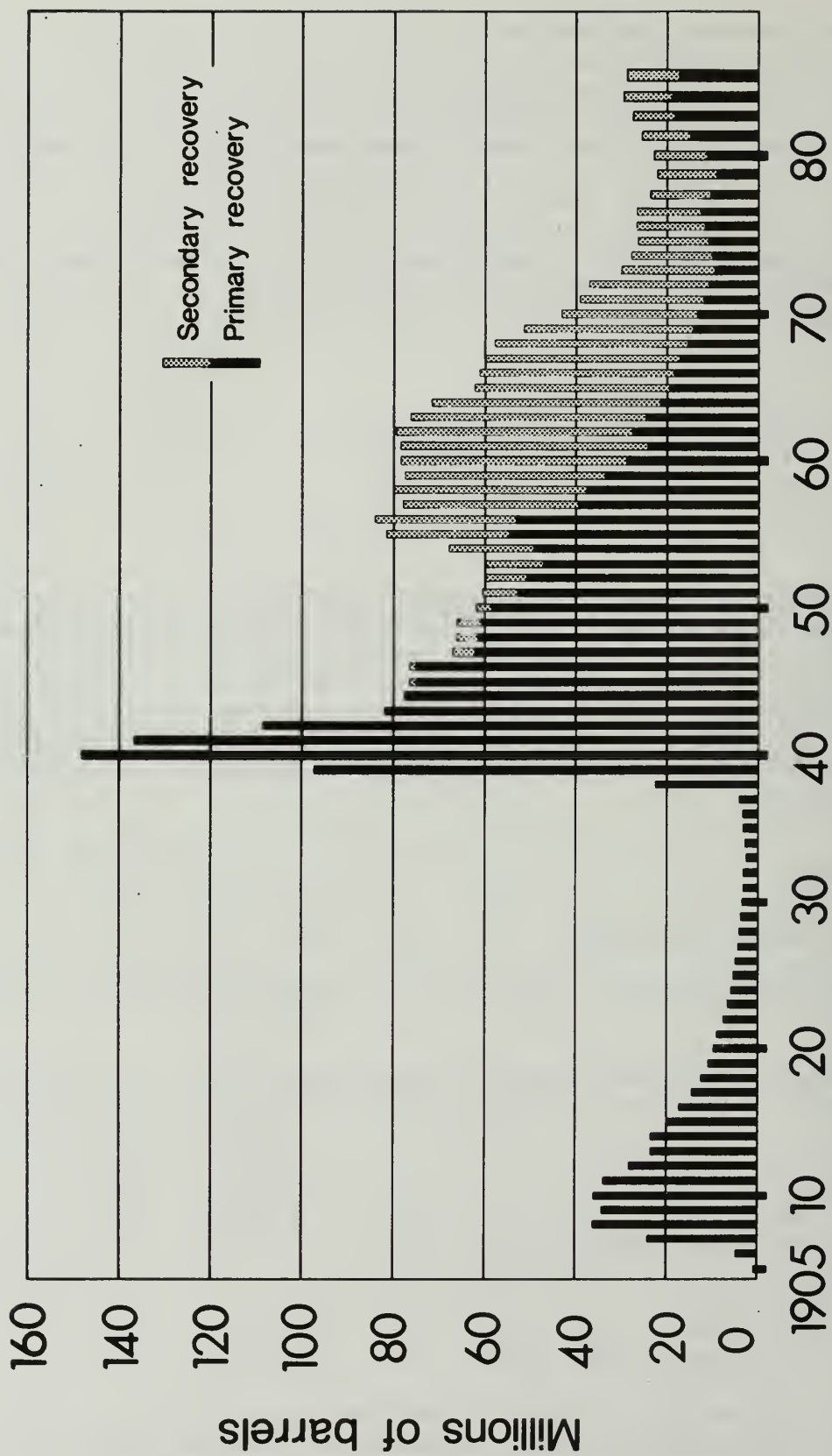
Economic Trends and Outlook

Crude oil production in Illinois in 1984 was 28,900,000 barrels, 1.0 percent less than in 1983.

A tabulation of the number of holes reported drilled by the oil and gas industry in 1984 and 1983 follows:

	Number of wells	
	1984	1983
Oil and gas tests		
New holes	2,732	2,624
Old holes drilled deeper	28	44
Service wells		
New holes	102	86
Old holes drilled deeper	0	1

The 2,732 new holes drilled in 1984 resulted in 1,576 oil wells, 20 gas wells, and 1,136 dry holes. New wells were drilled in 58 of the 102 Illinois counties. Illinois ranked 8th in total wells drilled for 1983,



Annual crude oil production in Illinois.

and 14th in total oil production. The following 12 counties accounted for 66 percent of the reported new holes drilled.

<u>County</u>	<u>Number of holes</u>	<u>Percent of State totals</u>
Edwards	231	8.5
Wayne	230	8.4
White	190	7.0
Crawford	189	6.9
Clay	184	6.7
Brown	143	5.2
Fayette	142	5.2
Jasper	111	4.1
Schuyler	111	4.1
Lawrence	102	3.7
Richland	85	3.1
Wabash	83	3.0
	<u>1,801</u>	<u>65.9</u>

Discoveries reported in 1984 included 9 oil fields, 1 gas field, 50 new pay zones in existing fields, and 51 extensions to fields. The new fields are all small.

Oil and Gas Program for Illinois

The Survey's Oil and Gas Program encourages the petroleum industry to explore and develop resources in Illinois by providing the comprehensive data collection, mapping, and stratigraphic research required to generate new petroleum targets and new techniques for exploiting existing fields and plays.

Constructing, expanding, and enhancing the ISGS geological data base depends on work of the Geological Records Unit and on communication between Survey geologists and the petroleum industry operators and geologists who provide the Survey with drill cuttings, diamond cores, crude oil and gas samples, seismic data, and other information pertinent to the search for hydrocarbons in Illinois.

Oil and gas data are made available to the public via: (1) an annual report on the petroleum industry in Illinois; (2) a monthly drilling report; (3) oil and gas pay zone maps (showing the geographical areas underlain by oil production from individual rock layers); and (4) maps showing the elevation of selected strata.

Survey scientists in turn use the Survey's geological data base to study and interpret the geologic and geochemical phenomena controlling petroleum generation, migration, and accumulation in Illinois. The findings are presented to the public via Survey publications and other journals, talks to interested groups, and conversations with individuals



Joan Crockett, Oil and Gas, examines an outcrop of the oil-producing Aux Vases Formation near Anna, Illinois, as part of a study to determine the depositional environment of this reservoir rock.



Donald Dickerson, Geochemistry, obtains output from new Rock-Eval instrument used to characterize organic matter in source rock and evaluate the potential of the rock to generate crude oils.

visiting or calling the Survey. This interaction of people and ideas sparks new interest and insight into Illinois' hydrocarbon potential, which is economically important to all its citizens. Current research projects are described in following paragraphs.

Petroleum Geology Investigations

Petroleum Geology of Lower Chesterian Sandstones in the Illinois Basin (Seyler). This research on stratigraphic traps in the sandstones and limestones of the Aux Vases Formation encourages petroleum exploration in Illinois by increasing understanding of the deposition and distribution of an important reservoir rock and providing the means to predict the location of reservoirs.

Stratigraphic traps in the Aux Vases are complex and consequently poorly understood. They are dependent on lateral changes in grain size and thickness of the unit. To delineate areas with the greatest potential for future production, the Survey has initiated studies of approximately 10,000 geophysical logs and many samples from cores and outcrops.

Reservoir Characteristics of the Aux Vases Formation in Illinois (Seyler). A study of petroleum reservoir characteristics in the Aux Vases Formation revealed many of the causes of poor well completions and decreasing oil production from the Aux Vases. Study results can be used to increase production from the Aux Vases Sandstone, and avoid costly mistakes in completing wells. The continued use of x-ray diffraction and scanning electron microprobe analysis of reservoir characteristics in other oil bearing rocks should lead to better understanding of appropriate completion practices.

Shallow Petroleum Occurrences in West-Central Illinois (Seyler, Crockett, Schwalb, and Howard). A 2-year, nationwide exploratory interest has focused on Silurian oil accumulations 450 to 650 feet deep in the area east of Quincy, and there is demand for a plausible exploration model. Data necessary for developing such a model--including additional cores, sample sets, and gamma neutron logs--have been acquired during the past year.

Statewide Grid of Surface-to-Basement Lithologic Cross Sections (Schwalb, Seyler, Jacobson, Howard, and others). Illinois' deep frontier consists of a sequence of sedimentary rocks up to 2 miles thick, underlying a mile-thick section within which successful exploration has occurred. What little is known of petroleum potential of these deep rocks has come from a few deep tests and current Survey petroleum source-rock research sponsored by several major oil companies.

Work has begun on a network of 6 north-south and 8 east-west lithologic cross sections. Data for these sections are coming from well logs and drill cuttings. Some industry-acquired proprietary seismic data may become available for coordination with and extrapolation of our well data. Greater knowledge of the deep subsurface conditions will lead to

the generation of new "play" concepts, which serve as incentives for industry to participate in exploring the deep basin. Two north-south sections are ready for drafting.

Possible Meteorite Impact Structure in Southeastern Macoupin County, Illinois: Implications for Hydrocarbon Accumulation (Howard, Heigold, and Nelson). A map showing the elevation of the floor of the long-abandoned Superior Coal Company Mine No. 1 southwest of Litchfield, Macoupin County, reveals a near-circular feature approximately 2.5 miles in diameter. The mine floor within the 1.5 mile-wide central portion of the feature rises to more than 65 feet above the surrounding area in the 0.5 mile-wide enclosing ring depression. The imposition of such a large and clearly defined structural anomaly upon a gentle, regional south-eastward dip raises questions concerning its origin.

The central uplift and concentric ring depression suggest a pre-Pennsylvanian meteorite impact, which could have a wide range of implications with regard to oil entrapment, depending on when the impact occurred and the rocks it affected.

Trend surface analysis of Bouger gravity anomaly maps indicate there is no definitive gravity anomaly associated with this structure; however, a vertical magnetic intensity map of the area shows that a magnetic "high" coincides with the structure. In early summer, seismic data will be acquired across the area.

Source Rock and Migration Studies

Occurrence and Maturation of Sedimentary Organic Matter in the Illinois Basin (Barrows, Dillon, Schwalb, Seyler, Damberger, and Harvey). The purpose of this 3 1/2-year-old study sponsored by nine major oil companies is to analyze the entire Paleozoic sediment sequence of the Illinois Basin and to determine the nature and maturity of dispersed organic material in the sediments. An extended Summary Report recently completed includes many tabulations and figures that present raw data collected and evaluations of these data. The final report should be released by mid-1985. This study has delineated the major source rocks for hydrocarbons and their degree of maturation throughout the Illinois Basin. Maturation values for nonvitrinite organics in rocks older than Devonian have been compared to reflectance values of vitrinite.

Organic Geochemistry of Illinois Basin Crude Oils and Possible Source Rocks (Risatti, Dickerson, M. Chou, and Schwalb; with J. Hatch, Oil and Gas Division, U.S. Geological Survey, Denver). Goals of this study are (1) to characterize crude oils in producing levels of the Illinois Basin, (2) to correlate oils to their source rocks (by matching oil/source rock pairs having the same organic biomarkers), and (3) to

study the maturation, migration, and biodegradation of Basin oils. Study findings may improve predictions of the possibility of finding crude oil in deep formations in the Basin, and will provide valuable information related to the search for hydrocarbons in Illinois.

The Survey has just purchased a Rock-Eval instrument, which is being used to evaluate rapidly (20 min per sample) the nature of organic matter in geological rock formations and its potential to generate crude oils.

Specific objectives of the project are: (1) to evaluate chemically the organic fractions ($>C_9$) of Illinois Basin crude oils to determine their characteristics, genesis, and relationships to each other and to other crude oils; (2) to evaluate chemically the soluble organic fraction from Illinois Basin shales and from suspected source rocks to determine their relationships to Basin oils; (3) to extract, identify, and evaluate biomarkers from Basin crude oils, shales, and source rocks to facilitate correlations of oils and source rocks and to establish migration and maturation indices; and (4) to synthesize and interpret data for publication.

Extracts of shale are being studied to determine variations in the composition of organic matter. Core samples from a northwest-trending cross section of the Illinois Basin were studied, using solid state carbon-13 cross polarization magic angle spinning nuclear magnetic resonance, gas chromatography/mass spectrometry and field ionization mass spectrometry techniques. Results indicated a regional variation of the aliphatic and aromatic hydrocarbon composition. Findings suggest that the organic variation of the shale is mostly due to the differences in thermal maturity of the shale organic matter and that the pristane/ $n-C_{17}$ ratio may be used as a maturity parameter in the study of oil.

Related research is being conducted on the recently discovered, extremely thermophilic, deep sea methanogenic bacterium Methanococcus jannaschii, which contains a novel macrocyclic, polar lipid in its cell membrane. The uniqueness of this lipid suggests that it may be useful as an environmental biomarker in crude oils and organic rich sediments. The organism is currently being grown at various temperatures (56 to 86°C). Lipids from the harvested cells will be studied, using gas chromatography and gas chromatography-mass spectroscopy, to determine if molecular and compositional changes occur with temperature changes.

Composition of Natural Gas

Flow Testing of Oil and Gas Wells (Riley). Within the past year, 33 gas and gas/oil wells were tested to determine gas flow rates; these analyses help operators determine the commercial feasibility of producing from the wells and provide a data base for analysis of future gas finds. This testing service is the only one of its kind in the state apart from in-house testing by the major gas companies (strictly for their own wells). As a result of the ISGS testing and consultation, natural gas that would have been flared or shut in is now being used.

Of particular interest is a new gas field in Pike County, southeast of the old Pittsfield Gas Field, near the town of Time. Five wells in the area have been tested. The Prentice Gas Field in Morgan County, discovered in 1953, has generated additional interest. Six new wells drilled in the area were tested by the ISGS, and four were found to be capable of producing gas.

Chemical and Isotopic Composition of Natural Gas (Riley, Coleman, and Liu). Samples of natural gas are analyzed quantitatively by gas chromatography to determine composition, specific gravity, and Btu value. Isotopic analyses are performed on all samples collected. In addition to the 33 samples collected in the field this year, 58 more requiring precise analysis were submitted by gas producers and by Survey staff engaged in research. The information gained from these analyses adds to the ISGS data base and aids in distinguishing natural gases from gas from other sources. The Survey has been asked by gas storage companies to determine whether gas present in wells near their storage facilities is native or has leaked from the storage field.

BIOGEOCHEMISTRY

Biogenic Acetate and the Origin of Biogenic Natural Gas (Risatti; and J. M. Hayes, Department of Chemistry, Indiana University). It is widely recognized that biogenic methane is much more depleted in carbon-13 than is thermogenic methane; the source of gas, as identified by isotopic analysis, has become a standard tool in the exploration for oil and gas. To optimize the usefulness of this tool, it is necessary to understand more about the reactions and processes which cause variations in the isotopic composition of methane.

The depletion of carbon-13 in biogenic methane correlates well with what is known about isotope effects associated with the CO_2 -reduction pathway of methane production, but the isotopic characteristics of the acetate-to-methane pathways, now recognized as the major source of sedimentary biogenic methane, are unknown. Moreover, the isotopic composition of the acetate that must serve as the substrate for these organisms is also unknown.

Experiments are completed culturing acetogenic bacteria with CO_2 and H_2 as a substrate. The residual gases and aliquots of acetate product were collected at various times during growth and the ^{13}C composition of the CO_2 and of the acetate methyl and carboxyl groups has been determined. The data indicate that biogenic acetate is isotopically fractionated with respect to carbon when it is produced from CO_2 and H_2 . The magnitude of this fractionation and the carbon isotope composition of the acetate methyl and carboxyl group has been investigated. These data explain the "anomalous" carbon isotope values found in sedimentary biogenic methane and with further refinement may serve as an indicator of specific microbial activities in sediments.

Methanogenic bacteria have also been grown on acetate, and the carbon isotope effects associated with the dissimilation of acetate have then been determined. The isotope effects at the methyl and carboxyl carbons of acetate have been measured separately. We found that the dissimilation of acetate is accompanied by substantial isotope effects that can be directly related to other aspects of the carbon isotopic composition of marine sediments.

Oil and Gas Statistics

Petroleum Industry in Illinois (Van Den Berg and Elyn). This annual report was issued as Illinois Petroleum 126 in April 1985. Part I summarized oil and gas developments: Part II dealt with waterflood operations.

Monthly Oil and Gas Drilling Report (Van Den Berg). Reports of oil and gas wells drilled are compiled monthly for petroleum industry personnel, government officials, landowners, and others interested in current oil activities.

Oil and Gas Developments in East-Central States in 1984 (Van Den Berg). A manuscript on developments in Illinois was combined with similar reports from Indiana, Kentucky, and Tennessee into one paper for publication in the Bulletin of the American Association of Petroleum Geologists.

Cooperation with Interstate Oil Compact Commission (Van Den Berg). A summary report on oil and gas developments is prepared annually for the Commission. An annual stripper well report showing number of wells, acreage, and production by fields is also prepared for the Commission.

Reports for Other Organizations (Van Den Berg). A detailed report on each well drilled in Illinois is made to the American Petroleum Institute (API), which gathers similar reports throughout the United States. These are the basis for statistical reports issued by the API and the American Association of Petroleum Geologists (AAPG).

Other Service Activities

During the year, the Oil and Gas Section responded to 118 letters and 1,126 telephone inquiries from the public, industry, and government agencies, and 515 visitors came to the section seeking information on oil and gas. A geophysical logging workshop was co-sponsored by Dresser Atlas and the Oil and Gas Section for Survey personnel.

INDUSTRIAL MINERALS

Industry News

Quarry operators in the vicinity of Cave-in-Rock, Hardin County, have cooperated in the acquisition and installation of a fine-grinding facility in connection with their limestone operations. Their major market at this time is for rock dusting within underground coal mines, but they are also looking into the filler and other markets.

Limestone and Dolomite

Urban Encroachment on Dolomite Resources of the Chicago Area (Mikulic). Dolomite rocks are the main source of construction aggregate in the Chicago area. As reserves of these rocks become depleted and urban sprawl encroaches on potential quarry sites, the search for new sources of crushed stone becomes urgent. The goal of this study is to set guidelines to ensure continued production of low-cost, high quality stone in the Chicago area. Attention is being directed to the possibility of locating new quarry sites and towards the development of underground mining in the area. Work to date has been largely restricted to an examination of the subsurface records and study of present quarries to determine the quality of individual rock units, and to a lesser extent has included a search for undeveloped sites and the determination of their potential. The comprehensive subsurface (drill core) holdings of the Metropolitan Sanitary District of Greater Chicago will be examined as part of this project.

A paper summarizing the problem of urban encroachment of quarries was presented at the 20th Forum on the Geology of Industrial Minerals last spring and will be published as part of the Proceedings of the Forum.

Examination of Some Characteristics of Fine Ground Limestone that Affect Uses (Khan and Baxter). Producers of finely ground limestone in Hardin County market their product for rock dusting in coal mines (to prevent explosions of coal dust) and are interested also in the filler market. Certain characteristics of limestones affect their use as rock dust and fill. Water-wetting properties determine the dispersibility of fine-grained particles. In the humid mine air, the rock dust loses its dispersibility and becomes less effective. In this study we are attempting to (1) measure the natural water-wetting properties of the limestone and the finely ground product and (2) determine the influence of "waterproofing agents" on the dispersibility of rock dust treated with these agents.

High brightness (measured by reflectance) is required for many mineral filler applications. Measurements are being made of the reflectance and specific surface area of sequentially ground limestone to quantify the correlation between brightness and particle size, and attempts will be made to improve brightness by chemical, thermal, or physiochemical treatments.

Sand and Gravel

Geologic Characteristics of Illinois Gravel Deposits Affecting IDOT Freeze-Thaw Test Results (Masters; and Evans, former employee). The research component of this cooperative project between the ISGS and IDOT (Illinois Department of Transportation) was completed during the previous reporting period, and the final contract report is being reviewed. As an extension of this project, a preliminary report on findings was prepared by Masters and William Sheftick (IDOT) for presentation at a meeting of the Board of Directors of the National Sand and Gravel Association in January 1984.

A Proximal Outwash Deposit--Beverly Gravel Pit, Cook County, Illinois (Masters). This gravel deposit is part of a large outwash plain complex that is an important source of construction aggregate in the northern part of the Chicago metropolitan area. A description of the gravel deposit and interpretation of its proglacial environment of deposition was prepared for this site as background material for a stop on a field trip, entitled "Depositional Environments and Correlation Problems of the Wedron Formation (Wisconsinan)," held in conjunction with the April 1985 meeting of the North-Central Section, Geological Society of America, in DeKalb, Illinois.

Use of Clay Mineralogy and Radiocarbon Dating in the Interpretation of Sedimentary Units, Mound City, Illinois (Reed, Masters, and Glass). This study is largely based on test boring data from a U.S. Army Corps of Engineers bentonite-slurry trench project on the river side of the levee between Mound City and Cairo, Illinois. The data seem to indicate that valley fill deposits under the floodplain of the Mississippi and Ohio Rivers near the southern tip of Illinois contain a clay mineral assemblage that indicates a possible contribution from Paleocene deposits exposed in nearby uplands. Radiocarbon dates indicate that the well-sorted sand and gravel in the valley fill is Holocene in age rather than Wisconsinan. The availability and interpretation of these drilling data are important to the understanding of the groundwater system and distribution of aggregate resources of the area. An abstract with this title has been accepted for presentation as a talk and will be published in the Proceedings of the conference on "Pleistocene Geology and Evolution of the Upper Mississippi River Valley," to be held in August 1985 at Winona, Minnesota.

Preliminary Study of Chert from Portland Cement-Grade Gravels: Specific Gravity Distribution Versus Freeze-Thaw Test Expansion (Khan and Masters). This study is an attempt to test one of the conclusions of the recently completed cooperative ISGS-IDOT gravel study, that chert having a low specific gravity (less than 2.35) is more closely related to freeze-thaw test expansion than is chert with high specific gravity. Results obtained so far partially support this conclusion. As the amount of material having a specific gravity of more than 2.55 and lighter than 2.65 increases, the expansion decreases; however, the relationship is not linear. Reduction of the amount of low specific gravity chert by some method such as float-sink beneficiation or the use of

impact crushers should eliminate excessive expansion in gravel sources where chert is the predominant cause of freeze-thaw expansions.

Fluorspar, Lead, and Zinc

Intrusive Breccias at Hicks Dome (Bradbury and Baxter). Samples from Office of Minerals Exploration (OME) drill core were obtained from the U.S. Geological Survey during a recent visit to Denver and have enabled the completion of this manuscript. The manuscript is now in the review process and will be published by the Survey.

During field mapping, approximately 45 breccia bodies at Hicks Dome were identified. Most are vertical dikes up to 10 feet wide; some are bodies of undetermined shape. The dikes exhibit a roughly radial arrangement around the dome. Composition ranges from carbonatitic with inclusions of igneous rock to shatter breccias consisting of monolithic fragments of the immediate Devonian or lower Mississippian wall rocks. A few of the breccias are mineralized. Some contain only small amounts of fluorite and barite; one exposure contained 0.1-mm crystals of bertrandite (beryllium silicate) in fluorspar; a weathered body in an exploration trench contained monazite (thorium-rare earth phosphate); and a deeply buried body (intersected in a drill hole) contained anomalous amounts of thorium, REE, Nb, Be, in addition to fluorite, barite, and traces of sulfides. Hicks Dome is believed to have been formed by the explosive release of gases from an alkaline magma at depth. Whether or not the dome contains commercial amounts of fluorspar and the more exotic components is not known at this time.

Lead and Zinc Drilling and Other Records (Bradbury). During the approximately 10 years (1944-1954) the Galena Field Office was in operation in the Northwestern Illinois Zinc-Lead District, ISGS geologists logged all exploration holes drilled in the district. Many hundreds of historical logs were copied from company and individually held records, and many mines and mining areas were mapped and described. These records are now on file at the Survey.

During the past several months, the Pb-Zn records have been arranged, and a description of the main ingredients of the system is being prepared. The confidentiality status of all sets of logs in a U.S. Bureau of Mine atlas has been reviewed and a list of logs still regarded as confidential has been made.

Clay

Bulk Mineralogy of Illinois Clays and Shales. Computer File of Test Data on Illinois Clays and Shales (Hughes and Cowin). Acquisition and computer storage of retrievable analyses and information on the location of Illinois clays and shales is critical to the future definition of resources. The information can be used to locate particular types of clay resources, to correlate specific clays with engineering

needs, and to study changes in composition that result from depositional and postdepositional processes. Manufacturers who request a source of suitable clay for bricks, wall tile, flower pots, cement clay, cat litter, or similar products can now generally get a quick response to their questions. This file grows by 1,000-3,000 samples per year. A new microcomputer system is being used to facilitate storage and retrieval of these data.

Architectural Practices in the Use of Bricks (I. Schousboe and Hughes). Professor Schousboe, who has made a sabbatical tour of the United States and Australia to survey the problem of moisture expansion of brick, is planning to collaborate with Hughes on a publication for architects that will outline the range of potential problems associated with brick, explain ways to avoid the pitfalls, and relate the properties of bricks to the task of designing and constructing lasting structures.

Periodic Visitation, Sampling, and Consultation with Illinois Clay Producers (Hughes). These visits are continued as time permits. Raw material samples are usually taken, so that a backlog of compositional data is available to analyze and explain future production difficulties.

Kaolin Slurry Production from St. Peter Sandstone Slimes (Khan, Berggren, Hughes, and Cowin). Determination of the feasibility of marketing kaolin waste clay as a by-product of silica sand production is being analyzed. Kaolin is present as a minor constituent of the sand; it could be extracted from the present-day waste streams or from tailing ponds. The research attempts to measure the resource, to determine the response of the clay to grinding and flotation, to improve methods of dewatering the clay or removing the clay by flotation, and to design an integrated method of producing and marketing the kaolin.

In order to establish optimum grinding conditions for upgrading low-cost filler grade clays into high-quality coating grades, the effects of various operative parameters on grinding of clays from an abandoned sand washing tailing pond were studied, using a grinder that made a wobbling motion. The generally held notion that the viscosity of the media affects the breaking of the particles was not found to hold true for this system. Almost the same degree of pulverization could be achieved with plastic beads as with glass beads 2.5 times heavier.

Air floc flotation, a process developed at ISGS to upgrade fine-grained materials, was used to separate fine-grained quartz from clay in material collected from the tailing pond of a sand washing plant. Better results were achieved with this process than with the well-established froth flotation. Using a feed that was 28 percent clay and 72 percent quartz, a clay product consisting of 77 percent kaolinite and a quartz product consisting of 92 percent fine silica were achieved with air floc flotation recovery; 74 percent of the clay and 90 percent of the quartz were recovered. The concentration of clay and quartz obtained with froth flotation was 68 and 87 percent, respectively, with recoveries of 60 and 88 percent.

Silica and Industrial Sand

An Alternative Method of Cleaning, Classifying, and Drying Industrial Sand Products (Khan and Baxter). The method used in the production of industrial sand products consists of the following steps: (1) elutriation, (2) drying, and (3) screening of the mine run sand. The elutriation step requires the pumping and handling of large amounts of water, which means high energy costs. To recover and market kaolin and fine-quartz more efficiently, alternative methods are being investigated for application to St. Peter Sandstone deposits of Illinois. To recover the kaolin and fine-grained quartz and reduce energy consumption, alternate flow diagrams are being considered. One such alternative includes removal of clay by air-floc flotation, wet screening of the deslimed material, and subsequent drying of the individual size fractions. Up to 80 percent of the material finer than 200 mesh has been removed by this method.

Other Industrial and Strategic Minerals Activities

Midcontinent Strategic and Critical Minerals Program (Illinois) (Baxter, Sargent, Schwalb, and Lapish). As part of the Midcontinent Strategic and Critical Minerals Program being conducted by the Branch of Central Mineral Resources of the U.S. Geological Survey, ISGS staff and investigators in 10 other states have compiled data on the geologic characteristics and mineral favorability of a large area of the Midcontinent United States bounded on the east in Illinois by longitude 88°. During the period of this report, ISGS prepared and delivered to USGS: (1) a structure map of the top of the Pre-cambrian basement, (2) a map showing the location of basement and other deep holes in Illinois, (3) five cross sections, along even-numbered lines of latitude and longitude, showing the lithologies comprising the Sauk, Tippecanoe, Kaskaskie, and Absaroka sequences in Illinois, (4) a thickness and lithofacies map of the Sauk Sequence exclusive of basal Mt. Simon Sandstone, and (5) a map showing the distribution of mineralization in small mines, prospects, outcrops, quarries, and borings, sphalerite in coal seams, and Neda oolitic "iron ore" in subsurface and outcrop locations. In addition, we reviewed a USGS map showing mining districts in Illinois. The delivery of these items completes the initial stage of this cooperative effort.

Baxter and Bradbury attended a meeting February 4-5, 1985, in Denver, at which time the next phase and future cooperative topical research was discussed.

Limited Occurrence of Gold in Illinoian- and Holocene-Age Deposits in Henderson County, Illinois (Masters, Klasner, Western Illinois University). This project is an extension of work being done to update and publish J. E. Lamar's work on "Limited occurrence of gold in Illinois" (Masters, Khan). The state-wide report will be an overview listing reported occurrences of gold and additional data on selected sites. The Henderson County work will be published separately because

of the extensive information contributed by a local prospector and because this is the only location in which we have been able to recover gold from an outcrop of glacial deposits. (During preliminary sampling, one small flake of gold was found by sluicing a 150-pound sample collected from a sand and gravel pond in the Illinoian-age Kellerville Till.) These reports will help fill an information gap on the occurrence of gold in Illinois and help meet a persistent demand from the public for such information.

Service Activities in Industrial Minerals

During the past year, the Industrial Minerals staff responded to numerous inquiries: 71 personal visits, 191 telephone requests, 56 letters, and referrals from other staff members. Responses ranged from lengthy letters based on a search of literature or data on file to limited field or laboratory work. Inquiries generally concern past and present areas of mineral production or potential areas for future development.

Facilities maintained by the Industrial Minerals Section for sample testing include binocular and petrographic microscopes as well as equipment for thin- and polished-section preparation, crushing and grinding, particle-size analysis and heavy-liquid separation. The Survey's Applied Research Laboratory provides access to other mineral separation techniques.

MINERAL ECONOMICS

Projects

Illinois Mineral Industry in 1981-1983 and a Preliminary Review of Mineral Production in 1984 (Samson). This report incorporates final 1983 and preliminary 1984 data on Illinois mineral industry. The summary of the report is included in the introduction to the Mineral Resources Section of this Annual Report.

Economic and Regulatory Environment for the Low-Temperature Charring and Desulfurization of Coal (Bhagwat, Stephenson, Kruse, and Johnson). Two ISGS economic studies of low-temperature charring support the conclusion that pyrolysis of Illinois coal is an economically sound approach to coal utilization. The first study by Bhagwat and Johnson reviews past studies on charring and analyzes the regulatory and economic environments within which the char must compete as a fuel. The regulatory environment includes existing EPA and SIP regulations as well as the proposed acid rain regulations. The economic analysis includes the study of coal and other fuel and nonfuel products and the elasticity of demand. Based upon similar experiments at a pilot plant by FMC Corporation in the early 1970s, the study presents three product price scenarios and their implications for the economic margins available for desulfurization of char. The results (in 1984 dollars) indicate that in

the base case scenario with a char price of \$29 per ton, the desulfurization of char cannot be accomplished economically. However, in an alternative scenario with higher char prices of \$46 per ton, an economic margin of \$12 per ton of coal can be expected. The Bhagwat and Johnson findings were presented in a paper published in the proceedings of the "First Annual Pittsburgh Coal Conference" held at Pittsburgh, PA, September 17-21, 1984 as well as in ISGS Reprint 1985A.

A second independent study by Stephenson and Kruse was made (in 1990 dollars) in the Minerals Engineering Section. In this study the base case scenario assumes a char price of \$46 per ton. Other economic assumptions in this study regarding plant size, plant life, cost of capital, capital structure, tax rates, and depreciation pattern were the same as in the earlier study by Bhagwat and Johnson. Stephenson and Kruse included an estimate of investments needed for the proposed unit for desulfurization of char as well as the operating costs of the desulfurization unit, and calculated the return on investment. In their base case scenario, Stephenson and Kruse estimated a DCF/ROR of 22.8 percent, which is adequate to cover the cost of capital. A sensitivity analysis under different product price assumptions caused the DCF/ROR to vary between 16 percent and 29 percent.

Both studies indicate that the pyrolysis of coal is a venture with above average risks but with sufficient economic incentive to encourage exploration of the marketability of the char, oil, gas, and elemental sulfur. The Stephenson and Kruse findings will be published in the ISGS Illinois Mineral Notes Series (in press).

Kohle im Illinois Becken--Ein energiepolitisches Dilemma (Bhagwat). This paper, written at the request of the West German mining magazine "Glueckauf" discusses the dilemma in which the states find themselves due to energy related policies in the United States. The conflicting goals of achieving clean air and promoting greater use of the largest bituminous coal deposits of the U.S. are discussed. The strengths and weaknesses of the midwestern coal industry and the importance of political decisions are highlighted. The paper will help to educate the European consumers about Illinois Basin coal as a first and necessary step toward creating markets for our coal overseas.

Preliminary Economic Analysis of Desulfurization of Illinois Coal by In-Situ Preparation of Iron Sulfide Catalysts (Bhagwat). The report was written for the CRSC-funded project by Shiley et al. The experimental results of Shiley et al, were analyzed; they indicate that a compliance quality solid fuel can be produced by this method. The application of an input-output model approach determines that under the present product market conditions a maximum amount of between \$20 to \$35 per ton of coal could be spent annually on desulfurization by in-situ preparation of iron sulfide catalysts and the process could still break even.

An Analysis of Coal Surface Mining Equipment in Illinois (Bhagwat). The "stripping ratio" in surface mines indicates the amount of soil that must be moved for every ton of coal produced. Thus stripping ratio

affects the cost of mining and the competitiveness of coal in a significant manner. However, the stripping ratio often shows little or no statistical correlation with cost per ton in the real world (see ISGS Reprint 1983A). One cause of such a lack of correlation could be the use of mining equipment that is much larger than needed. This report analyzes the sizes of equipment being used at Illinois surface coal mines, estimates the equipment sizes actually needed, and compares the needed versus actual equipment sizes in order to determine if, in fact, equipment overcapacity exists. Results indicate that such overcapacity does exist and discusses the reasons for it. If measures could successfully be taken to reduce the overcapacity, significant cost savings could be effected that might give Illinois an edge in the coal markets.

Directory of Sand and Gravel and Stone Producers of Illinois (Samson). The first printing of the directory published last year is out of stock, and an updated version of the directory is in preparation.

Economic Evaluation of Coal Mines Using Longwall Technology in the U.S. (Bhagwat). Work on this project has been slow and intermittent due to lack of manpower. Data collection is still in progress, but no work has been done on the project in the past 6 months. The project is considered important to the future of Illinois coal industry and will stay on active file.

Service Activities

- Telephone inquiries, letter inquiries and visitors asking for information accounted for approximately 10 percent of staff time.
- Office conferences with visitors and students seeking information and guidance required about 2 percent of staff time.

GEOLOGICAL RECORDS UNIT

The Geological Records Unit is the legal repository for records of oil and gas, mineral, water well and engineering drilling within Illinois as mandated by Illinois Statute (Chapter 96 1/2 - Natural Resources Conservation of Oil and Gas). The oil industry, coal industry, hydrogeologists, engineers, land use planners, land owners, and the general public rely heavily on this data base. The document files and well log books are constantly used by staff and visitors. The level of drilling activity has increased pressures on space; however, a Survey-run copying system implemented in June 1984 under NRIF has significantly streamlined Unit operations and increased the security and accessibility of the data base.

<u>Collections</u>	<u>1984-85</u>	<u>Total</u>
Processed drill hole records	6,164	260,500
Books of processed drill hole records		749
Skeleton logs (records of wells drilled prior to 1920)		17,950
Skeleton log books		40
Confidential log books		15
Out-of-state log books		14
Miscellaneous hole record books		9
Geophysical logs	3,091	106,899
Coal pluggings	2,033	15,764
Filing numbers - Sample Sets	593	64,850
Filing numbers - Cores	73	12,951

Data Acquisition

<u>Basic Data</u>	<u>1983-84</u>	<u>1984-85</u>
Oil permits	5,750	*5,013
Oil permit corrections	244	672
Water permits	4,936	5,213
Plugging affidavits (oil and water)	1,243	2,316

Logs

Electric logs	1,302	1,395
Micrologs	140	157
Radioactivity logs	1,051	1,362
Miscellaneous geophysical logs	<u>191</u>	<u>177</u>

Total geophysical logs	2,684	3,091
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	<u>1983-84</u>	<u>1984-85</u>
Drillers logs	425	390
Drilling time logs	429	449
Company sample and core studies	130	157
Geologic tops	270	202
General data (completion information)	1,685	2,427
Water well and test hole logs	2,791	5,362
Miscellaneous	<u>167</u>	<u>179</u>
Total new logs received	8,581	12,257

*Includes coal test permits. DMM combined all no-fee permits into one numbering system this year.

<u>Backlog</u>	<u>1983-84</u>	<u>1984-85</u>
Files to be typed and placed in main files	2,767	3,100
Unprocessed water well records	20,000	22,000
Incomplete records due to unanswered requests to companies	2,000	9,800
Plugging affidavits for producing wells	1,204	120

Although 53 percent more records were completed and placed in the main files this year than last year (6,163 and 4,022, respectively), the backlog of files to be completed continues to create problems for the staff and the public. As progress is made in the final processing of files, the pressure for space in the main files increases. Finding time to request required logs and information from delinquent operators also continues to be a problem.

Computer Project

Automation of the Geological Records Unit's records processing system, initiated during 1984, is continuing. Oil well permits are added to the computerized Basic Data File on a weekly basis, as a first step in processing records. The weekly permit list and two card sets are now being machine-generated. A computer program providing machine generation of several cross-reference files is in the final test phase. Information in the Basic Data File was essentially unavailable for retrievals until this year, when it was transferred to the Prime computer. Because this change in status occurred only recently, we do not know yet how much additional file editing will be necessary. Some problem areas have been identified. Approximately 20,000 key-punched records are now being transferred to the Prime system, and approximately 21,500 oil well records and 25,000 water well records must be entered; these remaining records must be incorporated in the system before additional improvements in computer procedures can be implemented.

Service Activities Summary

	<u>1983-84</u>	<u>1984-85</u>
Visitors days	3,436	2,373
Letters	110	150
Files used by public and staff	125,173	75,469
Phone calls	2,321	2,314
GRU log orders processed		1,911

The copy system implemented in June 1984 has improved the security and accessibility of the data base. Records are refiled quickly and therefore, accessed more efficiently. The convenience of phone and mail orders for machine copies of records has reduced the number of visitors. Space for seating of visitors is inadequate only during peak periods.



Expansion in progress at the Geological Samples Library will provide more space to store the Survey's ever-increasing collection of sample sets. Researchers from the ISGS, oil companies, universities, and government agencies use this data base. Shown at work are Harry McKinney, Oscar Richter, and John Klitzing.



GEOLOGICAL SAMPLES LIBRARY

General

The Geological Survey began collecting samples in the early 1900s when the United States Geological Survey donated a series of drill-hole samples to the State Geologist. Today, the Geological Samples Library stores drill cuttings and cores as mandated by Illinois Statute (Chapter 96 1/2--Natural Resources Conservation of Oil and Gas). The Samples Library staff receives, sorts, processes for storage, retrieves, and conducts all administrative functions required to archive and maintain these important collections of samples and cores. This unique sample repository houses a collection of samples representing billions of dollars invested in Illinois by petroleum and mining companies for more than 80 years. The collection attracts users from across the country, enhancing the investment potential in Illinois by both in- and out-of-state companies. Activities of the Geological Samples Library Unit for the past year follow:

Cuttings

Five hundred ninety sets of well sample cuttings (65 sets more than we acquired last year), representing more than 786,700 feet of drilling and utilizing 15 linear feet of space in the Samples Library, were added to our permanent file during the reporting year. The Samples Library files of 64,899 well cuttings represent more than 739,036,700 feet of drilling utilizing 1,400 linear feet in a 3,780 square foot area in the Samples Library.

An additional 142 oil and water wells are awaiting processing. (At the present time, there is about a 10-month interval between the time cuttings are received and when they are processed into our permanent files.) Also, 285 oil well sets requested by the Survey are awaiting processing at the Evansville Sample Cut, a commercial firm to which we subscribe (109 samples less than last year's balance at the Sample Cut).

Additions to our permanent files consisted of:

- 203 oil test sets received, of which 200 sets from rotary drill wells were washed; 3 sets from cable tool wells were processed dry
- 221 washed sets purchased from Evansville Sample Cut
- 166 water well sets processed dry

The number of samples from oil tests requested by the Survey (462) is considerably lower than last year's 781. We have received about half the oil well sample cuttings requested, and a much lower percentage of water well cuttings.

Cores

During the reporting year, 73 sets of cores, condensed from an initial 4,622 feet of drilling cores, were collected, examined, and processed into the permanent files. The entire collection of 12,950 sets of cores on permanent file (representing more than 810,396 feet of core drilling) is stored on steel racks in an area covering approximately 4,200 square feet of the Samples Library.

Other Sample Collections

During the past year, 100 Pleistocene (P-series) samples were collected, examined, and processed into our permanent files. Our collection in this sample category now totals 23,451 individual samples.

Additional bulk samples that have been chemically analyzed or used as reference materials in research projects were added to the temporary files; 23,100 of these samples are on temporary file in the Samples Library.

Supplies

The Geological Survey is required to provide sample bags for the collection of well sample cuttings that are requested by the State. During the past year the Samples Library supplied drillers and operators with 64,500 sample bags for requested well cuttings.

Summary of Service Activities

Requests for services of the Samples Library staff increased during the past year. Telephone requests regarding availability of samples or cores, location information, file numbers, and space to study samples are handled daily by GSL staff. The Samples Library office contacts drillers by letter to inquire about delivery of samples from completed oil tests; 245 such letters were sent to drillers and operators concerning cuttings from 325 oil tests requested by the Survey. The response to this mailing is as follows:

<u>Year</u>	<u>Letters</u>	<u>Wells</u>	<u>Responses</u>	<u>Wells Received</u>	<u>Wells not Received</u>
1983	219	317	72	22	50
1984	245	325	147	60	94

Visitors and staff members referred to our files 502 times and retrieved 1,911 sets of samples or cores for examination. This represents a 52 percent increase in the number of samples studied from the previous year. A breakdown shows that (1) on 206 occasions 736 sets of samples or cores were examined by staff members at the NRB or Annex

facility; and (2) on 296 occasions 1,175 sets of samples or cores were examined by 178 visitors to the Survey facilities. Visitors to the Annex facility represent a wide range of geologic interests. Independent consultants and representatives of major oil companies, universities, and governmental agencies are typical visitors at the Samples Library. Of all visitors to the Annex, 37 percent were from out-of-state:

59 (33%) indepen-	66 (37%) representa-	53 (30%) representatives of
dent Geologists	tives of oil companies	universities or governments

<u>In-State</u>	<u>Out-State</u>	<u>In-State</u>	<u>Out-State</u>	<u>In-State</u>	<u>Out-State</u>
48 (27%)	11 (6%)	28 (16%)	38 (21%)	35 (20%)	18 (10%)

Samples Library personnel assemble rock and mineral kits annually for distribution to Illinois schools. The labeled 35-specimen rock, mineral, and fossil set is a collection designed to familiarize teachers and students with the rocks and minerals of Illinois. This past year Samples Library staff assembled for distribution 160 specimen kits and filled 6 orders to recondition sets already assigned to schools.

The Samples Library office houses the Survey's microfiche collection of well log information and makes sales of copies or assists visitors who wish to examine this collection of 63,000 microfiche. Last year 25 visitors or staff examined 116 fiche.

Other Projects

To expand the samples data base and inform the staff and public about samples and cores available, the Samples Library office has completed a core index file that identifies all cores on file in the Samples Library that are available for study by visitors to the Geological Survey; the 8,000 cards, arranged by county, list the size of core, and provide relevant geologic data. Visitors and staff interested in the ISGS core collection can quickly identify those cores available for study. The Samples Library also added significant new storage space for cuttings following a re-design of some shelving and space needs.

The Samples Library staff coordinated a cooperative project with the University of Illinois Geology Department and the Ohio Geological Survey in the transfer of the late Dr. George White's research samples. Dr. White was retired Head of University of Illinois Geology Department. Some 2,200 samples in 2-pound paper cups were transported from the University of Illinois to the Annex; they were sorted, condensed, packed into 42 core boxes, and shipped to the Ohio Survey. Many of these samples were collected from northeastern Ohio coal strip mines that are now reclaimed and essentially irreplaceable.

ENVIRONMENTAL GEOLOGY PROGRAM



Wally Morse, Groundwater, wearing required protective clothing, measures water levels at the Wilsonville hazardous waste site to determine hydraulic conductivity of sediments.

ENVIRONMENTAL GEOLOGY PROGRAM

The Environmental Geology Program addresses concerns of Illinois citizens about their financial security, safety, and health in relation to the environment. The Survey developed the concept of environmental geology, now a widely accepted field of geology, in the early 1960s, and the program has continued to grow since that time. The aim of this program of research and service is to provide basic geologic data (and interpretations of these data) to assist government, industry, and the public in making decisions and taking actions to protect and enhance the natural environment. ISGS environmental studies focus on landslides, earthquakes, mine subsidence, groundwater resources, waste management, lakes and rivers, and resource-based land use planning.

ENVIRONMENTAL STUDIES AND ASSESSMENT

The Environmental Studies and Assessment Unit and its parent, the General and Environmental Geology Group, are just over a year old. The Unit was organized by internal transfers of four geologists from the Stratigraphy and Engineering Geology Sections and now has a staff of six full-time and two half-time people. The increase in staff was made possible by grant and contract funding associated with three large projects: the Long-Term Ecological Research (LTER), the Lands Unsuitable for Mining Program (LUMP), and the Fermilab Environmental Screening project. These projects have strong common threads: all require the cooperation of several Divisions of ENR, and all require the collection of geologic data and the application of that data to environmental issues of interest to the State.

Illinois Lands Unsuitable for Mining Program (LUMP)

Lands Unsuitable for Mining Program (Gross and DuMontelle). This program, funded by the U.S. Office of Surface Mining, contains two mandates: (1) preparation of objective land reports in response to petitions by Illinois citizens who ask to have a particular area declared unsuitable for mining; and (2) construction of a data base that can be used as a reliable basis for informed decision-making. This year efforts were concentrated on building the data base.

ILLIMAP Update (Environmental Studies Unit, Environmental Systems Research Institute, and DuMontelle). The ILLIMAP computer file of section and township lines coordinates is being converted for use on the Prime 750 computer by Environmental Systems Research Institute (ESRI). Detailed quality control checks have been an integral part of the input process to ensure accurate conversion of the files. Retrieval programs were written for efficient plotting of well locations having specific attributes (for instance, wells with samples or cores, wells deeper than 600 feet, water wells, or engineering borings). These well locations have been plotted successfully by the Prime 750 system. The preliminary ILLIMAP plots are being tested on a county-by-county basis. A Legal-to-

Lambert conversion program is also being tested. ESRI has completed 37 county files, and expects to complete conversion of the remaining ILLIMAP files by June, 1985. ESRI is also updating the files for the 400 7.5-minute quadrangle maps published after the original construction of ILLIMAP. When ESRI finishes this update, the ISGS will continue update work until all of Illinois is covered by modern 7.5-minute topographic maps.

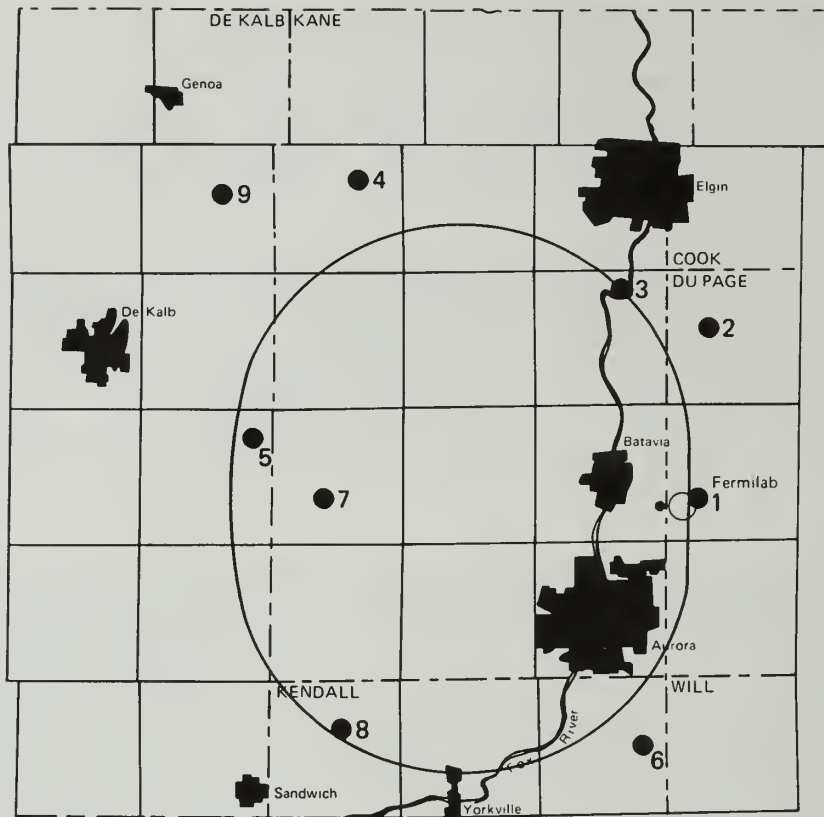
Completion of the Statewide Map Data Base on the Prime 750 (McKay, Krumm, and Gross). Numerous maps have been automated and added to the LUMP Geographic Information System (GIS): (1) 25 15-minute quadrangle maps showing strippable coal resources; (2) four 15-minute quadrangles showing landforms, soils, escarpments, and slope; and (3) statewide maps of Quaternary deposits, bedrock geology, soils, escarpments, stack units, drift thickness, coal resources, structural features, and pipelines.

Quality Checking of GIS Data Sets (Krumm, McKay, and J. Miller). Data already added to the GIS and data now being compiled for the GIS have been carefully checked to ensure the quality of the automated data sets. Final checks were made on slope and landform variables of four 1:40,000-scale Integrated Terrain Unit Maps automated in FY 84. Preliminary checks were completed of pre-automation copies for 30 (of a total of 56) 1:62,500-scale maps of strippable coal reserves to be mapped in FY 85. Landform units were delineated on ten 1:40,000-scale quadrangle maps that were delivered to ESRI for compilation into the FY 85 Integrated Terrain Unit mapping. Data from the automated statewide stack-unit map were checked against original data and corrections made in the automated file.

Long-Term Ecological Research (LTER)

Sedimentation History and Sedimentary Environments of Upper Mississippi River Pool 19 (Casavant and Gross). A geological map of sediment in the 45-minute reach of Mississippi River Pool 19 was completed as the M.S. thesis of Deborah Casavant. The map is being used as the basis for the habitat compartments in the biological modeling work of the LTER team and illustrates the distribution of 14 sediment types based on hundreds of sediment grab samples and cores. Pool 19 was formed by construction of a dam in 1913. The pool is still filling with sediment, and sedimentation rates are greater than 10 cm per year in the lower end of the pool.

Automation of Maps and Data (McKay, S. Miller, and Gross). Nine 7.5-minute quadrangles covering Pool 19 of the Mississippi River in western Illinois were digitized for use in the Prime 750 GIS. Each quadrangle now has maps that depict landforms, data points, bed materials, locations of depth profiles, and biological compartments. These maps are being used in the modeling of the hydrological and biological balance of the river. They are also used for tracking sampling progress and for planning future sampling programs in this long-term project.



This map shows locations of nine test holes drilled in the fall of 1984 for the Superconducting Super Collider (SSC) Accelerator project.



Members of the Survey's SSC Task Force team work with a drilling crew at test hole 1 site.

Methods Handbook for LTER (R. A. Cahill). The Large River LTER research program involves four independent agencies located in five widely separated areas. Coordination of analytical and field programs and establishment of standard laboratory and field techniques that will be maintained throughout this 30-year study are therefore critical. This manual, compiled at the ISGS, describes 50 LTER field and laboratory procedures for research associated with this project. Designed to be used as documentation of LTER methods, it also provides a mechanism for judging the internal compatibility of ISGS data sets, and when used in conjunction with other LTER site data, their external compatibility as well.

GEOLOGY FOR PLANNING

Geology for land-use planning was the original objective of environmental geology when this term was coined at the ISGS in the 1960s. Resource-based land-use planning involves mapping the vertical as well as areal distribution of geologic materials and presenting this information in a form nongeologists can understand and use. Planners are given information on favorable areas for burying wastes, locating water resources, building roads, houses, or large industrial facilities, and exploring for minerals.

Fermilab

Geological Study on Siting the Proposed 20 TeV Superconducting Super Collider Accelerator (SSC) in Illinois (Geological Task Force and other staff). Many ISGS staff, in addition to the Geological Task Force, are involved in this major effort to bring to Illinois a \$4-6 billion facility to house one of the largest scientific research programs ever undertaken in the United States. The final draft of the preliminary geologic feasibility study (Phase I) was completed in July in collaboration with Fermilab personnel. This report was released by Fermilab for publication by the Survey as Environmental Geology Note (EGN) 110.

When the staffing of the Task Force was completed, an accelerated effort was made to develop detailed geologic maps of the study region using the existing data base, and to locate test drilling sites to refine the geology and stratigraphy and obtain hydrogeologic and engineering data on the bedrock and drift.

The drilling program was initiated in late August and completed November 26. Nine test holes were drilled for the first phase. Test holes reaching from about 312 to 492 feet deep were drilled around the circumference of one example ring location proposed for Fermilab. To adequately characterize the geologic, engineering, and hydrogeologic properties of the region, split-spoon samples of the drift were collected and the bedrock was continuously cored. The cores, mostly of the Silurian dolomite and Maquoketa and Galena Groups as well as the glacial

drift, were described in the field. Test holes were geophysically logged, pressure packer data were obtained for determining permeabilities, and piezometers were set to measure water levels. The cores were then carefully packaged for further laboratory description, study, and tests.

Shallow seismic reflection and refraction studies provided information on the depth and characteristics of the shallow bedrock--information useful in determining where to locate the test holes.

Data and samples from the drilling program are currently being studied and processed, and engineering tests on selected bedrock cores are in progress. A preliminary report on the drilling program--including data on each test hole--is currently in preparation and a draft has been submitted to Fermilab for review. Test drilling data are currently being compiled with other well data and geophysical data to update existing maps. Phase 2 of the test drilling began in early April of this year.

Fermilab Environmental Screening (Gross, Hines, Clark, McKay, Killey, and S. Miller, and INHS, ISWS, and ISM). In order to bring the Superconducting Super Collider (SSC) project to Illinois, it is necessary to identify and avoid or mitigate any potential environmental problems. The SSC is envisioned as a tunnel 10 feet in diameter, bored in dolomite, with a circumference ranging from about 60 to 100 miles. A special appropriation of the legislature was used to fund an examination of many environmental issues involved in this immense project. All three Surveys and the State Museum are involved in the environmental screening.

Preliminary environmental screening completed in July concluded that environmentally sound sites for the SSC ring could be found west of Fermilab. The study area includes 36 townships. To date, 56 maps and data sets have been compiled. Mapping is being done at a scale of 1:100,000, and reports are being prepared for each map. These data are being prepared for transmission to Illinois Institute of Technology Research Institute (IITRI), the firm employed to write the State of Illinois proposal to the U.S. Department of Energy.

ISGS senior staff have been involved in preparation of reports and presentations, participation in conferences with IITRI and Fermilab, meetings with environmental groups, and overall coordination of this project.

Siting the Superconducting Super Collider in Illinois (Gross, Kempton, Kolata, Stenzel, Killey, and many others). ISGS staff wrote, edited, and designed a publication highlighting advantages of an Illinois location for the SSC, describing work done to date by the ISGS and other State agencies, and discussing technical and environmental issues related to the project. The publication was prepared at the request of DENR as a report to the Governor and members of the 84th General Assembly. The report was published in color by DENR and released by Governor Thompson at a press conference.

Other Projects

Engineering Geology of Chicago (Dixon and T. R. Maynard, Chicago Dept. of Public Works). This paper, prepared for the Bulletin of the Association of Engineering Geologists, will be part of the series, Geology of the Cities of the World. It discusses geologic factors that have affected the growth and development of Chicago and geotechnical methods used to found structures and mitigate various environmental constraints.

Sources of Information on Engineering Geology and Related Topics for Northeastern Illinois (Dixon, Dowding, DuMontelle, Forslev, Hurley, Maynard, and Vanderpool). Soon to be issued as EGN 111, this publication describes basic data and services available in northeastern Illinois. It was produced jointly by the Geotechnical Division of the Illinois Section of the American Society of Civil Engineers and the North Central Section of the Engineering Geologists, in cooperation with the Illinois State Geological Survey.

WASTE MANAGEMENT

The Survey's program in waste management began in the early 1960s and has expanded greatly over the years as Illinois has become a major producer of hazardous and nonhazardous wastes. The Survey program of waste management is interdisciplinary, incorporating several geologic and chemical specialties.

To help in the urgent task of developing methods of managing wastes safely and economically, the ISGS and the other two Surveys, the State Museum, and DENR's Springfield office this past year formed the Hazardous Waste Research and Information Center (HWRIC).

Landfills/Septic Systems/Groundwater Contamination

Statewide Landfill Inventory (Dixon and Hensel). This project, part of the HWRIC program, consists of three tasks: (1) making an inventory of all known disposal sites in Illinois that includes information on location, type, hydrogeologic setting, waste source(s), and background information for each set; (2) incorporating this information into the Hazardous Waste Research and Information Center data base; and (3) preparing a report and map summarizing the site inventory and background data. The project is funded by the Department of Energy and Natural Resources.

Potential Contamination from the Application of Sludge on Agricultural Land in Rockton Township, Winnebago County, Illinois (Berg, Morse, and Johnson). This project evaluates potential contamination of groundwater and sediments from the application of sewage sludge on agricultural lands in Rockton Township. Since late 1983, 15 wells have been monitored and preliminary results show that the groundwater contains

more nitrates in areas where sludge has been applied than where it has not been used. The wells will be sampled three or four more times through the summer of 1985, and a report will be submitted to the Rockton Board of Supervisors, the initial contracting agency.

Groundwater Monitoring Plan and Assessment Activities (Johnson, Herzog, Hensel, and Dixon). Several tasks mandated by the General Assembly during the 1983 and 1984 legislative sessions were assigned to the ISGS and ISWS. The tasks in this contract were divided into four basic programs: (1) special studies related to groundwater quality in Illinois as defined in the Currie Bill (HB 3193); (2) services associated with the Water Use Act of 1983; (3) studies designed to enhance the Water Inventory Program conducted by the Water Survey; and (4) development of an Aquifer Assessment Plan for Illinois. The Geological Survey is involved in all except the third program.

The Currie Bill mandated that DENR, in cooperation with the Environmental Protection Agency and the Department of Public Health, conduct a study of groundwater quality in Illinois. Geological Survey staff are primarily concerned with evaluating groundwater quality in the immediate vicinity of hazardous waste facilities and assessing the effectiveness of current regulations and procedures regarding groundwater monitoring at these facilities.

An inventory of hazardous waste sites in Illinois is being compiled in conjunction with another project, "A State-Wide Landfill Inventory." Several hazardous waste sites selected from this inventory are under review to determine the extent of groundwater contamination and adequacy of monitoring at these sites and the adequacy of guidelines and regulations in effect when these sites were developed. Recommendations for implementing an effective groundwater quality protection plan will be made on the basis of these observations and on information about the relationship of hydrogeologic conditions to contaminant transport.

The Water Use Act of 1983 requires that the Illinois Department of Agriculture, Soil and Water Conservation Districts, and the State Water Survey evaluate proposed high-capacity well sites in Illinois. The Geological Survey, while not included in the original bill, is assisting in these evaluations.

The Groundwater Section at the Geological Survey is cooperating with the State Water Survey in the development of a Groundwater Resources Assessment Plan (part of the Aquifer Assessment Program) that will address the need for an integrated program for groundwater resource assessment in Illinois. An outline and portions of the first draft of the plan have been prepared.

Coal Wastes

Effect of Oxidation and Weathering on Coal and its Sulfur Constituents (Khan, Berggren, and Hughes). ISGS investigations on the effect

of weathering on minerals associated with coal wastes showed that the trace element content of the weathered material decreases as the pyrite content is reduced; however, the decrease is small and most of the trace elements remain unleached. The degree to which pyrite and other minerals associated with coal in refuse piles are oxidized was found to depend on the manner of their disposal and the depth of the material in the pile. The results of this study were published in the Proceedings of the 1984 Symposium on Surface Mining, Hydrology, Sedimentation and Reclamation.

Coal exposed to air oxidizes rapidly, and this alteration adversely affects its processing behavior and its market value. ISGS studies showed that some of the reactive oxygen is loosely bound and can be removed by evacuating and heating the coal, thus restoring some of the original properties.

Hazardous Toxic Wastes

Geology and Hydrogeology of the Frink's Industrial Waste Site, Winnebago County, Illinois (Johnson and Berg). In cooperation with the Illinois Environmental Protection Agency, the Geological Survey and the Water Survey are investigating contamination of the groundwater from an industrial waste site north of Pecatonica in western Winnebago County. A drilling program was undertaken, detailed descriptions of geologic materials were made, and monitoring wells were installed to help determine the direction of groundwater flow and the potential contamination of groundwater resources of nearby residences. These wells are being tested periodically by the Illinois EPA to assess groundwater quality.

Study of Current Underground Injection Control (UIC) Programs and Practices (Brower, Hensel, Krapac; and Visocky, Nealon, Peyton of the State Water Survey). A project mandated through Senate Bill 1954 and House Bill 3176 has been initiated to study current programs and practices dealing with the underground injection of hazardous wastes and to determine if underground injection is an appropriate method of disposal. The ISGS and the ISWS are conducting the study for the Department of Energy and Natural Resources. Current state regulations and practices of the UIC program related to well construction, monitoring data, and permit applications are being reviewed and evaluated in detail. To assess the fate of the injected waste stream in the disposal zone and the potential effects of spillage on the surface or leakage from disposal zones on public water supplies, studies are being made of physical and chemical parameters of the waste stream, well equipment, surface and subsurface geology and native fluid in the injection zone. Geologic units having the capacity to accept and confine injected waste are being delineated. Alternatives to deep-well injection of hazardous wastes are being identified and evaluated and environmental and economic tradeoffs between deep well disposal and alternative disposal technologies are being reviewed. A report summarizing the results of this study will be prepared for the Governor's Office and the General Assembly.

Study of Clay Liners for Hazardous Waste Disposal Sites (Johnson, Cartwright, Griffin, Herzog, Stohr, and Risatti). The U.S. EPA Cincinnati Laboratory invited Survey staff members to submit a research proposal to study earth barriers (liners) for hazardous waste disposal sites. Survey staff met with the U.S. EPA and outlined a 4-year field study of the movement of water and tracers (contaminants) through clay barriers. The study will involve large-scale field experiments patterned after the trench cover study conducted over the past 4 years in cooperation with the U.S. Nuclear Regulatory Commission.

Effects of Surfactants on the Solubility and Sorption of PCBs by Earth Materials (J. Chou, Griffin, and Redding; J. J. Hassett, Agronomy Department, University of Illinois). According to the International Trade Commission, more than 43 million pounds of surfactants were produced in the United States in 1982. However, very little research has been done dealing with the codisposal, attenuation, or mobility of surface-active agents and their interaction with other organic pollutants in soil and soil materials. In this study, Aroclor 1242, a PCB formulation, was used as a model hydrophobic organic compound to determine the effect of various concentrations of surfactants on the aqueous solubility of PCBs, the effect of surfactants on the sorption of PCBs by earth materials, and the effect of surfactants on the mobility of PCBs in soils.

A preliminary study showed that in 1.0 millimole sodium lauryl sulfate (an anionic surfactant) and benzyldimethylhexadecylammonium chloride (cationic surfactant) solutions, the solubility of aroclor 1242 was approximately 2 and 55 times higher than in deionized water, respectively. The presence of surfactants in solution also dramatically affected the sorption of PCBs; the anionic surfactant caused decreased sorption, the cationic surfactant increased sorption. A second study using soil columns showed that PCBs leached with the anionic surfactant solution were much more mobile than PCBs leached with the cationic surfactant solution. To prevent migration of PCBs from a landfill, PCBs and related wastes and anionic surfactants should not be disposed of in the same landfill area. This study has provided valuable insights into the mechanisms of sorption of hydrophobic organic compounds and has provided data that may be useful for developing remedial actions at spill or waste sites.

Standardized Batch Adsorption Procedures for Soils and Sediments (Griffin, Roy, Krapac, and J. Chou). The objectives of this project are: (1) to develop standardized batch adsorption procedures for the collection of adsorption data applicable to the siting, design, and processing applications for hazardous waste disposal, and (2) to prepare a Technical Resource Document detailing the routine uses of these procedures, describing the scientific basis and rationale behind them, and providing guidelines for the interpretation of adsorption data.

This is a cooperative study involving the American Society for Testing and Materials (ASTM), the U.S. EPA (source of funding), and the ISGS. Study and development (primarily under the auspices of the ASTM)

have resulted in a simple and rapid procedure for measuring the relative potential of earth materials to remove chemical pollutants from contaminated water. More sophisticated, flexible procedures are now being developed that will enable researchers to construct an adsorption curve--a graphical/mathematical relationship used to estimate the amount or concentration of a chemical pollutant that will be retained (adsorbed) by an earth material. Several factors (temperature, pH, ionic strength, chemical stability, equilibration time, and procedures for mixing and separating pollutants) must be addressed before the adsorption data will be reproducible between laboratories.

The procedures nearing completion have been tested primarily with inorganic constituents (arsenic, barium, cadmium, lead, and zinc). Preliminary results indicate that these new methods yield satisfactory results. Information gained by applying these procedures will be used to select and prepare soil materials for hazardous waste barriers to protect the quality of groundwater.

Competitive Adsorption of Arsenic, Molybdenum, and Phosphorus by Soil Materials (Roy and Griffin). An additional phase of the EPA-funded project just described is a basic investigation concerned with competitive adsorption. Competitive interactions that occur in the field can reduce the capacity of soils and clays to remove (adsorb) potential pollutants from solution, thus increasing the mobility of the pollutants and the probability of groundwater contamination.

As a first step in studying competitive adsorption, the magnitude of competitive interactions between three anions (arsenate, molybdate, and phosphate) is being systematically defined, using three different soils. Results vary with soil type; however, they indicate that the magnitude of competition is substantial in some cases, and inconsequential in others. In an attempt to understand the observed results, differential isosteric enthalpy changes (an energy term related to the strength of bonding between the anion and the soil) are being estimated to determine whether these competitive interactions can be rationalized on a quasi-thermodynamic basis.

Mechanisms of Contaminant Migration Through a Clay Barrier: Case Study, Wilsonville, Illinois (Geochemistry, Groundwater, and Engineering Geology Section Staff). Routine monitoring of a hazardous waste disposal facility at Wilsonville, Illinois revealed that organic contaminants were migrating 100 to 1,000 times faster than predicted. A detailed hydrogeologic investigation of the site revealed that the local groundwater flow and gradient are dominated by a 45-foot-high coal mine refuse pile that causes radial flow from the pile through the trenches. Measurements of hydraulic head indicated that the vertical flow is much less significant than the lateral component of groundwater flow. Results of hydraulic conductivity tests and geologic investigations indicated that differences between laboratory and field measurements of hydraulic conductivities accounted for the higher-than-predicted migration rates. The flow of contaminants through relatively large joints or partings in natural materials apparently could not be simulated success-

fully in small laboratory specimens of "undisturbed" or recompacted soils.

The distribution of contamination in the groundwater was clearly related to the flow patterns. Time series sampling of monitoring wells in slowly recharging formations showed that concentrations of volatile organics varied widely through the recovery period.

Investigation of Failure Mechanisms and Migration of Industrial Chemicals at Wilsonville, Illinois (Griffin et al., Hughes, and Warren). Clay minerals are the principal constituents of natural land-fill liners and covers that tend to seal the impoundment. Clay minerals will expand or collapse in response to changes in water content, changes in amount and type of dissolved salts, and contact with various organic chemicals. Expansion of a clay liner can disrupt its continuity, and contraction will cause cracking and failure of the liner. Wilsonville investigations are designed to estimate the effects of various types of hazardous wastes on clay materials, to develop simple and inexpensive methods of evaluating different types of clay for use as clay liners, and to determine whether or not certain types of hazardous materials should be disposed of in landfills.

Three lines of investigations have been followed: (1) viscosity measurements of a clay-water slurry have been made to quickly estimate the effects of wastes on clays; (2) x-ray diffraction (XRD) of swelling clay waste mixtures has shown a tendency of individual chemicals to collapse clay minerals and cause leakage; and (3) detailed studies have



Waste is being exhumed at the Wilsonville hazardous waste site, where contaminants have migrated through the soils much faster than predicted. Survey scientists are conducting detailed hydrogeologic investigations here.

been made of the clay mineral composition at Wilsonville in areas with and without underlying colliery wastes.

Research during the past year has centered on developing methods of measuring viscosity in order to screen large numbers of samples with a relatively inexpensive viscosimeter. Emphasis has also been placed on finding and testing Illinois clays as a substitute for Wyoming bentonite in clay liners and covers.

Low-Level Radioactive Wastes

Siting of a Low-Level Radioactive Waste Disposal Site in Illinois (Johnson, Berg, Miller, and McKay). The Illinois Department of Nuclear Safety is funding a cooperative ISGS-ISWS study to develop a comprehensive list of criteria to be used in siting a low-level radioactive waste disposal facility. Criteria important in near-surface disposal (such as presence of aquifers, population density, or areas of natural resource concentration) have been mapped on a state-wide scale and may be used to identify potentially suitable areas for near-surface disposal. Mapping of criteria important in deep disposal will begin shortly. The final task of the 2-year project (completion date, June 30, 1986) will consist of the development of specific site evaluation criteria.

The Survey's GIS is being used to produce maps of factors that influence the suitability of land areas for disposal of low-level wastes. Maps of geologic, hydrologic, cultural, demographic, and natural resource factors have been produced by reformatting and combining map data input into the GIS by the Lands Unsuitable Program.

Study of Trench Covers to Minimize Infiltration at Waste Disposal Sites (Cartwright, Johnson, Herzog, Larson, Morse, DuMontelle, and Stohr). This generic study, funded by the U.S. Nuclear Regulatory Commission, was initiated in October 1980 because of concerns related to the leakage of low-level radioactive wastes at the Sheffield disposal site.

Several designs of layered-soil covers were tested through laboratory, computer, and field simulations. The layered covers varied in their capacity to impede infiltration, but all limited infiltration more than did a typical cover. The draft final report for this contract has been submitted.

Fabric Analysis of Compacted Clayey Soil (Su and Stohr). Knowledge of soil fabric should prove helpful in designing improved trench covers. To determine soil fabric, sample preparation procedures were investigated for their suitability for subsequent analysis by x-ray or by scanning electron microscopy. A clayey soil compacted by the standard Procter Test (ASTM D-698) was used in the tests. Comparison of air-drying, critical point drying, freeze drying, carbowax-impregnation, grinding, and fractography methods showed that the carbowax-impregnated sample is best for x-ray analysis, while fractography on both air-dried



Vickie Poole, Groundwater, conducts a temperature study to investigate migration of tritium in area surrounding Sheffield low-level radioactive waste disposal site.



Beverly Herzog, Groundwater, sprays chemical tracer on experimental trench cover being tested at the Sheffield site; later, determinations will be made of direction of water movement.

and carbowax-impregnated samples is appropriate for scanning electron microscopic observation.

Preliminary results show that soil fabric can be determined with confidence by either method; however, x-ray analysis is preferred because representative specimens can be prepared simply and quickly.

Service Activities Related to the Hydrogeology of Waste Disposal

Reports are prepared upon request for the Illinois Environmental Protection Agency and local health agencies to aid in processing applications for operation of disposal facilities. These reports require a compilation of all available surface and subsurface geologic information and a field survey of the sites by one of the Geological Survey's professional staff. During the reporting period, 29 reports and related letters were written. Some 100 questions were handled directly through telephone calls or through discussions with visitors, consultants, and the EPA.

Survey staff also advised IEPA on the hydrogeologic aspects of the underground injection of liquid wastes into deep-saline aquifers through Underground Injection Control (UIC) Class I wells. The State Geological and Water Surveys review new permit and renewal permit applications for deep-disposal operations in Illinois. In addition, the two Surveys, in conjunction with the IEPA, responded to more than 60 inquiries concerning deep-well disposal and made several site visits to UIC facilities. Interest in deep-well disposal continues to be high because of recent changes in regulations controlling surface and near-surface disposal of liquid and solid wastes. Illinois received primacy for all classes of UIC facilities in 1984, and since then all Class I well permits have been systematically reviewed to bring each well operation into compliance with the newly adopted UIC regulations.

GEOLOGICAL STUDIES OF ILLINOIS LAKES AND RIVERS

Lake Michigan Research and Service

Over the past decade and a half the Geological Survey has acquired an impressive information base for support of research and services in southern Lake Michigan: it contains data on more than 800 bottom grab samples, 300 bottom cores, 2,000 miles of geophysical profiles from 12 major lake cruises, 18,000 slides, 1,600 high altitude photos, and more than 30,000 chemical analyses. Dozens of ISGS publications and contract reports deal with environmental chemistry of sediments, stratigraphy of lake sediments, shore stabilities, fishery breeding sites, glacial till distribution, history of the lake, and history of lake levels. These data make possible service to numerous federal, state, and county and municipal agencies as well as to the public.



Sedimentation rates at the junction of the Illinois and Mississippi Rivers are being studied by radioemtric techniques in a cooperative study with the Water Survey. High sedimentation rates here are of concern.



Dr. James King, ISM, Survey staff, and Soil Conservation Service scientists studying topographic maps spread on the hood of an ISGS truck. They are selecting the next site for test drilling in the Long-Term Ecological Research project.

An important new project--the Scoping Study for Lake Michigan Research Issues--was initiated during the past year. Funded by the Board of Natural Resources and Conservation, the study is a joint effort involving the Geological Survey, the Natural History Survey, and the Water Survey. Late in 1986, the project staff will produce a recommended research agenda for State of Illinois agencies.

Increasing attention is being given to research and service related to elevated lake levels and the rapidly accelerating rate of shore damage and instability. Record lake levels are predicted for mid-year 1986, and ISGS activities are expected to accelerate accordingly.

Survey staff have provided information essential to new construction and planning for the lake shore, including the development of harbors at Zion-Winthrop Harbor, where state investments may exceed 30 million, and at Lake Forest, where an entirely locally funded facility is planned. In addition, maps and data have been contributed to planning for harbor changes connected with the proposed 1992 Chicago World's Fair at Burnham Harbor.

Scoping Study for Lake Michigan Issues (Holm, Collinson, Gatz, Gordon, and Lamb). This study is designed to review present and past Lake Michigan research, evaluate research capabilities and establish priorities for state supported research in Lake Michigan. Lake project files have been developed, and an extensive bibliography has been compiled. Thus far, 2,500 entries have been made in the bibliography, 300 projects have been evaluated, and four lectures by major administrators have been scheduled. More than 100 investigators from more than 50 agencies have been interviewed. Services have already been provided to the Great Lakes Commission, the International Joint Commission, Argonne National Laboratory, the Lake Michigan Interleague of Women Voters, and the Center for Great Lakes.

Hydrography and Sedimentology of the Zion-Beach Park-Winthrop Harbor Marina Site (North Point Harbor) (Collinson). A proposal to study the Harbor Marina Site was presented to the Illinois Department of Conservation in July 1984 and funded in December. Several mylar maps already have been prepared and delivered on an emergency basis, including maps of depth to till, a compilation hydrography, thickness of sediment, and sediment characteristics. Eleven boreholes were drilled on the site in December, a general base map and a depth-to-bedrock map were delivered in March, and in April new hydrographic profiles were run and a new detailed hydrographic map was developed.

A Drought Impact-Decision Model for Illinois (Changnon, Risser, and Collinson). Another joint study by the three scientific Surveys was begun in February to develop a drought index that will trigger government response to special climatologic, hydrologic, and environmental conditions. The project is being supported by the Board of Natural Resources. The Geological Survey is conducting a small, 1-year study focused mainly on examining Lake Michigan effects.

Lake Michigan Sediment Studies (Cahill). Since 1969 the Illinois State Geological Survey has been conducting investigations of the bottom sediments in Lake Michigan. A chapter reviewing investigations conducted by the ISGS was recently published in the book titled "Toxic Contaminants in the Great Lakes" (John Wiley and Sons).

Cesium-137 has been measured in 68 grab samples (from the upper 3 cm of sediment) collected in 1975 as part of a systematic study of Lake Michigan bottom sediments. Levels of ^{137}Cs are highly correlated with organic carbon, lead and zinc, and other anthropogenic trace elements. This indicates that atmospherically derived ^{137}Cs and other trace elements are being redistributed by sedimentary processes in Lake Michigan after being incorporated with suspended sediment.

Low-Level Aerial Photography Program for the Illinois Lake Michigan Shore (Collinson, Norby, and Sargent). Requests to use the ISGS aerial slide file were received from the Illinois Department of Conservation, the U.S. Corps of Engineers, the Evanston City Council, an Evanston consultant, the Illinois Natural History Survey, and a Lake Bluff riparian rights owner during the reporting periods (250 slides were distributed). Two photographic flights made during the year added more than 500 slides to the collection.

Fate of Dredged Materials Placed on Nearshore Bars--Lake Michigan (Collinson, Norby, and Sargent). Two sites where dredged materials have been placed in the water over the nearshore bar are being studied. The first site investigation, at the Main Beach at Illinois Beach State Park (IBSP), was requested by the Corps of Engineers and the Illinois Department of Conservation. The second, at Foss Park in North Chicago, was requested by the Illinois Division of Water Resources. Dredged materials from the Waukegan Commonwealth Edison Power Plant were placed at the IBSP site, and harbor mouth dredgings from Waukegan Harbor were placed at Foss Park. In late August, hydrographic profiles were made of the IBSP site. In September, site visits were made to Waukegan Harbor and Foss Park with administrative and engineering personnel of the Corps of Engineers and officials from the Illinois Division of Water Resources.

Rivers and Back-Water Lake Research

Sedimentation Rate Studies in Lakes Using ^{137}Cs and ^{210}Pb (Cahill and Autrey). High sedimentation rates in some Illinois lakes quickly degrade water quality and may reduce the useful lives of these lakes as water supplies. Radiometric techniques have been developed to measure sedimentation rates more quickly than conventional surveying techniques, and may replace or supplement these conventional methods. Since 1954 and 1963, ^{137}Cs has been used to measure sedimentation rates in 11 lakes. The rates ranged from 3.6 cm/yr above the Lock and Dam 19 on the Mississippi River to 0.9 cm/yr in Lake Paradise. A ^{210}Pb procedure was developed, using a radiochemical separation and counting of ^{210}Pb , and 127 subsamples from 9 cores have been processed by this technique. Rates measured include >0.1 cm/yr in Lake Michigan to <3 cm/yr in Lake Depue.

The State Geological and Water Surveys have completed a cooperative study comparing radiometric dating with surveying techniques, and are currently preparing a report of the study. Future work includes sediment surveys in Lake Peoria and sites that are part of the LTER study.

Geology and Hydrogeology of Heron Pond, Johnson County, Illinois (Berg, Morse, and Stohr). The study, another project with the Water Survey, was funded by the Illinois Department of Conservation, in part to save Heron Pond from erosional destruction by the encroaching Cache River. About 40 to 70 feet separate the pond from the outer bend of an eroded meander of the Cache River. Only 8 to 11 feet of alluvium lies over the bedrock between the river and the pond, offering only a minimum of natural protection from erosion. A few monitoring wells will be established to determine the groundwater flow gradient from the pond to the river, and engineering tests will be performed on the alluvium to determine an erodability index for these materials. These data, and data provided by grain-size analyses of the alluvium, will be important considerations in the design of artificial protection of this wetland natural history preserve. The Illinois Department of Conservation funded the project.

Wetland Proposal for the Des Plaines River (Berg, Collinson, and Johnson). All three Surveys are involved in this study, now in the planning stage, of a proposed reconstruction of a braided stream wetland in Lake County in the Des Plaines River. Drilling and detailed areal and stratigraphic mapping of this site will increase understanding of some of the potential environmental ramifications of such a project.

Erosion

Conceptual Models of Sediment Erosion and Deposition Processes in Illinois (Black and Gross). The loss of sediment from the landscape of Illinois, with the resultant deterioration in water quality and loss of capacity in water bodies, is a major, unsolved environmental problem in Illinois. To determine research needs for designing erosional control programs, 10 erosional models were constructed (for the agriculture, grassland, forest, mining, urban, construction, riverine, palustrine permanent wetland, palustrine seasonal wetlands, and lacustrine systems), an 800-citation bibliography was compiled, and a workshop was held to examine the issues. The final report is being published as a two-volume work that will be the first publication in a new series of Illinois Scientific Survey Joint Reports.

HYDROGEOLOGY INVESTIGATIONS

Almost half of the people in Illinois (more than 95% of the non-urban population) depend on groundwater as the source of domestic water, and many industries also utilize large quantities of groundwater. The ISGS and the ISWS assist residents, municipalities, and industry in locating and developing groundwater supplies and conduct research designed to expand our basic knowledge of groundwater in the state.



Dennis McKenna, Groundwater, examines soil profile at quarry near Mahomet as part of an irrigation study in which samples will be tested for moisture content, bulk density, and grain size.



This new seismic thumper provides seismic reflection/refraction data, particularly useful for groundwater exploration.

Groundwater Geology

A Hydrogeological and Geophysical Investigation of Groundwater Resources in Kane County (Gilkeson and Heigold). This 3-year ISGS-ISWS investigation funded by the county was initiated in 1983 to (1) evaluate groundwater resources in the glacial drift (sand and gravel) aquifers and the shallow dolomite bedrock aquifers of Kane County, and (2) provide information essential to the management and protection of groundwater resources in the county. Interpretation of results from the two geophysical methods (seismic refraction and electrical earth resistivity) used by ISGS staff to explore for groundwater resources defined a municipal-size, shallow groundwater resource located within the corporate boundary of Aurora on land owned by the city. Test holes drilled subsequently by the City of Aurora proved the value of these geophysical techniques; the city will be constructing a supply well to tap the resource in the near future. The ISGS and ISWS are assisting the city in the design of the well.

Many communities in Kane County are interested in locating shallow groundwater resources to supplement or replace their present supply from deep wells in the Cambrian and Ordovician bedrock. Water levels in the deep wells are declining and there is concern about the high concentrations of radium and barium that occur naturally in groundwater from the Cambrian and Ordovician bedrock over a major part of the county (see Groundwater Geochemistry).

Other communities that have requested assistance in locating sand and gravel aquifers are East Dundee, Geneva, Hampshire, Montgomery, St. Charles, and South Elgin.

Irrigation Potential and Impacts (Reed and McKenna). All three Surveys are cooperating in a project to develop an irrigation prediction model for Illinois. Areas chosen for study include the Arrowsmith, Gibson City, LeRoy, Mahomet, Maroa, and Monticello Quadrangles, an area of about 1,500 square miles in east-central Illinois. The role of the Geological Survey is to provide a geologic framework and define groundwater aquifers for small- to large-scale irrigation systems. Field samples of earth materials collected by the ISGS from a continuous core sampler will be compared with Water Survey samples collected from a nearby excavated pit. The samples will be analyzed for moisture content, bulk density, and grain size.

Hydrogeology of the Mississippi River Valley in West-Central Illinois (Piskin and Dixon). This study of the Illinois side of the Mississippi River Valley from Rock Island to Calhoun Counties describes the topography of the bedrock surface and the thickness and character of the unconsolidated deposits. Potential groundwater resources of those deposits are discussed.

Drift Aquifers in Northeastern Illinois (Piskin and Dixon). This project, conducted in cooperation with the Northeastern Illinois Planning Commission, is part of a continuing investigation of water

resources in the region. Sand and gravel aquifers in the glacial drift contain significant amounts of groundwater. Maps showing the distribution of the aquifers and a text describing the character of the aquifers are being reviewed.

Water Resource Potential of Basal Pennsylvanian Sandstones, Southwestern Shelf, Illinois Basin (Poole). Periodic droughts in this area of Illinois, in combination with the rugged topography and the poor aquifer characteristics of the thin glacial deposits and upper Pennsylvanian bedrock lithologies, have encouraged the development of surface reservoirs as sources for moderate-to-large municipal and industrial water supplies. Many individuals not connected to a reservoir system rely on shallow wells or cisterns or a combination of the two for their water supplies. Neither system provides adequate water supplies during the periodic droughts. This study of the distribution, quality, and movement of water from basal Pennsylvanian sandstones has important implications for this part of Illinois in terms of domestic and possibly light industrial water usage. Several maps illustrating the distribution and estimated quality of the water resources of the basal Pennsylvanian sandstones were completed, and a manuscript is in preparation.

Groundwater Geochemistry

Hydrogeologic and Geochemical Studies of the Natural Occurrence of Radioactive Elements and Barium in Groundwater in Illinois (Gilkeson). The ISGS research program on the geochemistry of barium, radium, uranium, radon, and thorium in groundwater from the Cambrian and Ordovician bedrock in Illinois has been completed. Scientists at Northern Illinois University, University of Illinois, Florida State University, University of Texas at Houston, Argonne National Laboratory, Atomic Energy of Canada LTD, and the Illinois State Water Survey cooperated in the investigation. Funding was provided by four contracts with the U.S. Department of the Interior. Findings are published in the Contract/Grant Report Series of the Geological Survey and in Research Reports of the Water Resources Center, University of Illinois. The report includes a discussion of geochemical mechanisms that control the occurrence of the natural contaminants and presents regional maps that show the concentrations in groundwater.

State-Wide Ambient Groundwater Quality Monitoring (Gilkeson, Brower, and Johnson). ISGS staff involved in an interagency program initiated in December 1984 to establish a groundwater quality monitoring network for Illinois helped complete four rounds of sampling from more than 100 selected public water supply wells. The IEPA--the lead agency in this project--has set up a special section with funding and field staff to routinely collect the water quality samples. Agencies involved in the program are the Illinois Environmental Protection Agency, the State Geological Survey, the State Water Survey, and the U.S. Geological Survey. Goals of the monitoring network are to characterize the background chemical quality of groundwater from Illinois aquifers sampled at discrete locations, investigate variations in chemical quality that may

occur naturally over time, and investigate changes in chemical quality that may be related to human activity.

Investigation of Microbial Activity in the Pittsfield Compressed Air Storage Aquifer (Risatti and Brower). After periods of 5 to 9 months, compressed air stored in the St. Peter sandstone at the Pittsfield, Illinois (Yakley Field) site becomes depleted in oxygen. Oxygen depletion in the storage reservoir may be the result of such processes as aerobic microbial activity, nonbiological redox reactions involving reduced chemical and mineral species (e.g., sulfide and ferrous ions and pyrite), or possibly a combination of both processes.

These investigations, preliminary in nature, do little more than confirm that there are variations in oxygen concentrations large enough to cause serious problems for industrial use of the compressed air. A more extensive project now being proposed would involve further studies to determine the cause of the observed variations and investigate possible remedial action.

Groundwater-Geophysics Studies

Assistance to Six Small Water-Short Communities in Illinois: Surficial Electrical Resistivity Surveys (Poole). This is the third and final report of a series dealing with the use of surface electrical resistivity surveys to assist small, water-short communities in Illinois in exploration for additional water resources. The six communities included in this investigation were identified as experiencing water shortages in a joint study by the Illinois Division of Water Resources, the Illinois State Geological Survey, and the Illinois State Water Survey. This project is funded by the Illinois Department of Transportation, Division of Water Resources.

Service Activities

Groundwater Geology Reports and Electrical Earth Resistivity Surveys (staff). Letter reports on groundwater geologic conditions are prepared at the request of citizens, industry, public water supply systems, and governmental agencies to provide information in the siting and development of new and supplemental water supply wells. Electrical earth resistivity surveys are conducted upon request for well sites at which a test well failed to obtain an adequate water supply. The surveys supplement the information summarized in the geologic report. In addition, numerous requests for general geologic information are answered.

During 1984-85, 401 letters, reports, and technical letters were prepared.

<u>Groundwater Possibilities Reports</u>	138
Public Water Supplies	20
Farms and Rural Residences	92
Irrigation	18
Industrial	8
 <u>EER Surveys</u>	 37
Farms and Rural Residences	
Public Water Supplies	
Irrigation	
 <u>General Technical Information</u>	 210
 <u>Miscellaneous Letters</u>	 12
Sieves analysis of well cuttings	(8 wells)
Study of samples from problem wells	4

These statistics do not include information provided by staff during the year in response to 1134 telephone requests and to 193 visitors who came to the Survey seeking help on specific problems.

Other Studies and Projects

Illinois Irrigation Association Convention and Midwest Water Well Exposition (Reed, Brower, McKenna, Hensel, and Piskin). The Hydrogeology Section staff participated in the annual IIA Convention, presenting a poster display that included a map of Illinois outlining principal aquifers capable of yielding large groundwater supplies for irrigation, and a series of diagrams showing research activities contributing to sound irrigation practice. A display of the Fermilab project and its impact on groundwater resources was shown at the Midwest Water Well Exposition held in Decatur. Survey research programs and services aimed at developing and safeguarding groundwater resources were discussed with well drillers and irrigators.

EARTH HAZARDS AND ENGINEERING GEOLOGY

Landslides

Analysis of a Slump-Type Landslide, Southwestern Illinois (Krumm). A landslide along the Mississippi River bluffs near Caseyville, St. Clair County was the focus of a detailed instrumentation and monitoring study. Ground movements have caused minor damage to one residence; continued movements could result in damage to other structures. Analysis of the data indicated that the failure zone is seated at the loess/till contact. The failure pattern and measured movements are typical of a rotational slope failure (slump), not a mine subsidence event.

Landslides in Illinois (Killey, DuMontelle, and Hines). The Landslide Inventory Map of Illinois MF-1691, compiled at the ISGS, has been printed by the Eastern Distribution Branch of the USGS, 1200 South Eades, Arlington, Virginia. The map will be included as a plate with ISGS Circular 534 (to be published this year), which describes the various types of landslides in Illinois and suggests ways to control unstable slopes.

Landslide Mapping on Geographic Information System (DuMontelle, Killey, Hines, and McKay). Data from the Landslide Inventory Map of Illinois are now being converted to automated form for inclusion in the Survey's Geographic Information System (GIS). The capacity to combine this information on locations and types of known landslides with maps already on the GIS (the Quaternary Deposits map, for instance) will facilitate the development of predictive maps of landslide-prone areas and slope instability problems affecting land use and zoning.

Earthquakes

Earthquakes in the Illinois Area (Killey, DuMontelle, Stenzel, and Heigold). A brochure titled "Earthquakes in the Illinois Area" prepared by ISGS staff members was published by the Illinois Emergency Services Disaster Agency for distribution as a part of series dealing with the hazards of earthquakes in Illinois. More than 500 copies of this brochure have been distributed.

Proposal to Study Seismic Intensity Enhancement Due to Loose, Unconsolidated Surficial Materials (Heigold, DuMontelle, Larson, and Berg). This proposal, currently being developed, will be submitted to the USGS Earthquake Hazards Reduction Program for possible funding. The first phase of the study deals with the characterization of loose, unconsolidated, surficial materials deposited in a variety of geologic environments in southern Illinois, the area of highest seismic risk in the state. The second phase of the study will focus on examining particle motions in response to man-made seismic sources. The result of the study should add to our understanding of this long-recognized but little analyzed aspect of seismic risk.

Mine Subsidence Activities

A Combined Information System of Coal Mine and Insurance Data (Bradford, Bauer, DuMontelle, Evans, Cacich, Brutcher, and Cooper). This system, developed by ISGS staff and partly supported by the Illinois Mine Subsidence Insurance Fund is being used to analyze insurance claims information gathered since 1979. Statistics derived from the directory indicate that only about 16 percent of these claims resulted from subsidence damage. Although insurance investigators are required only to determine whether damage to a property is related to subsidence, in many cases they identify the cause of the problem. These data provide the Survey with information on where Illinois soils are

susceptible to shrinking and swelling, where unstable conditions exist, and where compressible organic materials or poorly compacted foundation materials are located. Such soil problems and improper construction techniques and maintenance are indicated as the major problems for the homeowner, resulting in 1,956 claims (73 percent). Continued analysis of the claims data combined with maps of surficial deposits and other geologic information can facilitate identification of the causes of damage to property in Illinois.

Computer-Assisted Directory of Mine Subsidence Insurance Claims (Bradford, DuMontelle, and others). The directory has been transferred from the PDP 11/34 to the Prime 750 for additional flexibility, and the directory is now operational. Directory information will help the insurance industry in Illinois by allowing investigators access to non-confidential information on other damaged structures in the area they are investigating. Authorized personnel outside the Survey will soon be able to access the directory through their own microcomputers. The information will also be useful to Survey researchers investigating problematic soils and areas of high incidences of mine subsidence.

A demonstration of the computer data base was made in November to the policy committee of the Illinois Mine Subsidence Insurance Fund (IMSIF), which helps fund the project. (A personal computer at the funding agency was linked by telephone modem to the Survey Prime computer.) The IMSIF plans to continue to provide the Survey with reports of subsidence damage and contribute funding to help support IMSIF use of the Prime and to hire contract personnel to encode and enter data.

Subsidence on Agricultural Lands (Hines and Bauer). This study was conducted to determine the total area of land undermined in the state. Areas undermined by specific types of mining (i.e., longwall, room and pillar) were also calculated. The effect of coal mine subsidence was determined in several study areas to identify depressions. A tracing of the depressions was then superimposed over coal mine maps to determine the relative number of natural versus mine-related features. The study also included a survey of techniques used by farmers to reclaim subsided areas, and the success of these measures.

Cooperative Investigation of Lime Stabilization of the New Roadbed for Pennsylvania Avenue (Su, DuMontelle, and Stohr). The University of Illinois Operations and Maintenance Division requested assistance in evaluating the use of lime-stabilization techniques to upgrade a mixture of soil and roadbed materials during reconstruction of a section of Pennsylvania Avenue south of the Natural Resources Building. Under a cooperative research program established to conduct physical tests, aluminum access tubes were installed to monitor moisture and density changes of the subbase materials. The project will provide information that can be used in developing guidelines for lime stabilization of similar surficial materials mapped by the Survey in other regions.

Inter-Survey Geotechnical Laboratory Organization and Operation
(Miller, DuMontelle, Roeper, and Westcott). The Inter-Survey Geotechnical Laboratory provides services to the three Surveys and a number of contract-funded programs. During the reporting period, samples have been processed from a number of different projects including the Fermilab group, Friends of the Pleistocene, North Central Field Trip planners, Cache Valley Study group, Horseshoe Lake group, Long Term Ecological researchers, ISWS Sediment Monitoring Network engineers, Lake Springfield sediment researchers and others. Water concentrations of 3,200 samples and particle-size determinations (240 hydrometer, 120 pipette, 15 SediGraph, 320 sand fine splits, and 20 dry sieve) were completed by the staff.

GENERAL AND BASIC RESEARCH



Brian Trask, Coal Section, takes an elevation of a coal near New Burnside, Illinois, as a cameraman from WSIL TV films the process. The study is part of a cooperative mapping program (COGEOMAP) with the USGS.

GENERAL AND BASIC RESEARCH

GEOLOGIC MAPPING

Geologic mapping is fundamental to all economic and environmental programs at the Survey. Geologic data collected from field observations, test borings, sample analysis, and laboratory tests are compiled on a suitable map base and projected into a two-dimensional (sometimes three-dimensional) presentation of the earth's surface and subsurface.

The state's cartographic program, a cooperative effort of the ISGS, USGS, and other agencies, not only provides base maps for Survey studies, but also supplies cartographic information to a broad range of users. The jointly sponsored USGS, ISGS, and IDOT (Illinois Department of Transportation) topographic mapping program provides 1:24,000-scale 7.5-minute quadrangle maps covering the entire state. These maps are useful to planners, developers, builders, sportsmen, vacationers, and many others. The ISGS is also continuing to review satellite imagery, high altitude photography, and forms of remote sensing combined with digital modeling and other computer-assisted cartographic techniques.

Demands for programs oriented toward specific economic and environmental problems emphasize the need for a more active program of basic geologic mapping. For example, decisions to investigate for coal or oil are often based on regional mapping of structural geology. Criteria for selected sites suitable for safe landfilling of hazardous wastes are only as valid as the current status of geologic mapping. Mapping projects include both surficial (Quaternary) geology studies at the county scale and bedrock studies at the quadrangle scale. The cooperative geologic mapping program (COGEOMAP) offered by the USGS, patterned after its cartographic program, is a new component of this effort.

Surficial Geology

Geologic Materials to a Depth of 50 Feet in Illinois (Berg, Kempton, Miller, and McKay). Work has resumed on the preparation of a statewide stack-unit map showing the sequence of geologic materials to a depth of 50 feet. This map will be published as three plates (scale, 1:250,000) included in a short circular. This information is now in the Survey's GIS System, and some examples of individual geologic units will be extracted from GIS and presented as figures. The value of computerizing this detailed map having more than 5,200 map units will be emphasized. This map is the basic geologic map for land-use and resource-based land-use planning in Illinois.

Comparative Analysis of Surface Resistivity Surveys and Natural Gamma Radiation Borehole Logs in Illinois (Reed). Comparisons of natural gamma logs and surface electrical earth resistivity soundings were made at four locations within glacial sediments to identify sand and gravel intervals in the stratigraphic sequence--important in groundwater resource evaluation of glacial drift and alluvial materials in

Illinois. Data from vertical electrical soundings can be interpreted with greater confidence when correlated with results from nearby natural-gamma logs. Linear correlation coefficients between apparent resistivity data and natural-gamma radiation values can be determined in the field with a hand-held calculator.

Renewable Energy Resources of Illinois (Larson and Hughes). The Geological Survey is participating with the Water Survey and the Natural History Survey in the Board-funded investigation of the renewable energy resources of Illinois. An important class of renewable energy technologies is geothermal energy systems. One type of geothermal system, the geothermal heat pump, is being commercially installed in Illinois for domestic and light-duty industrial space heating and air conditioning. However, the basic physical properties of thermal conductivity and diffusivity are not known for Illinois soils. Researchers will collect representative samples of soils and analyze their thermal properties. Study results will be incorporated into the state-wide Geographic Information System so that maps can be prepared to show the range of thermal properties of soils in the state.

Bedrock Mapping

Cooperative Geologic Mapping Program with the U.S. Geological Survey in Southern Illinois (COGEOMAP) (Damberger, Nelson, Jacobson, Trask, Lumm, Devera, and Weibel). The U.S. Geological Survey provided significant support for basic ISGS geologic mapping in southern Illinois. The U.S. Geological Survey COGEOMAP program requires that state funds match federal funds; thus federal funding permits us to double our geologic mapping activities. If federal funding can be raised to the level originally requested, a 14-quadrangle area could be completed during the next 5 years. These quadrangles, located across the southern closure of the Illinois Basin, include the exposed lower portion of the coal-bearing sequence. Several of the coals known to occur here have never been mapped in detail, but coal resources in this region would probably be low in sulfur (because of the nonmarine origin of most of the rock sequence) and would be expected to have a higher heating value than most coals of Illinois. Due to their mostly fluvial depositional environment, they will probably be more local in extent than the better known seams of Illinois.

The area to be mapped is known to be traversed by numerous faults, and those faults near southeast Illinois may be mineralized. The recognition of previously unknown structures or the reinterpretation of others may provide new ideas to stimulate oil and gas exploration in the area.

Creal Springs Geologic Quadrangle (Trask and Jacobson). Detailed mapping during the past year has revealed more extensive coal resources than were previously known. The New Burnside and Bidwell seams contain substantial unmined coal resources. The Bidwell, in particular, crops out over a broad area in the northeast part of the quadrangle, where it

is up to 4.5 feet thick. Mining formerly reported from the northern part of the quadrangle and previously believed to be in the New Burnside seam actually took place in the Mt. Rorah seam, about 30 feet above the New Burnside. Additional abandoned mines found in the Mt. Rorah seam suggest that mining of this seam has been more extensive in the past than has been reported. The Mt. Rorah coal is up to 4 feet thick and contains a 1- to 4-inch claystone parting near the middle. Such thickness in numerous exposures suggests more extensive resources in this seam than previously thought. Mining has also taken place in the Wise Ridge Coal, which lies 20 to 25 feet above the Mt. Rorah seam. The Wise Ridge Coal locally reaches 2 feet in thickness.

Topographic Mapping and Cartographic Information

Cooperative Mapping Program with the U.S. Geological Survey (Scoggin and DuMontelle). A part of the cooperative topographic mapping program of the ISGS and the USGS begun more than 40 years ago is nearing completion. Included is the preparation of a map series of the State of Illinois with topographic coverage at a scale of 1:24,000. Of the 1,072 7.5-minute quadrangles which cover Illinois, 980 (more than 90%) have been mapped at least once. Of the 92 maps remaining to be completed, 48 are planned for completion in 1985, 20 in 1986, and 24 in 1987. The Illinois Department of Transportation provided part of the funding for completion of the series.

The USGS has issued a new Index to Topographic Maps of Illinois, now in booklet format (replacing the old flat map Index). This Index is valid indefinitely and is accompanied by a catalog, also in booklet form, which will be updated and reissued periodically as new maps are published, old maps are revised or abandoned, and prices are changed. The Index/Catalog combination is easy to use; it contains information about the types of maps available, map scales, map series, comparison of series, prices, and sources of USGS map products.

During this reporting period, our affiliate office of the National Cartographic Information Center received more than 262 phone calls, 130 letters, and 122 visitors requesting geodetic and general cartographic information. The Survey received 53 new maps in the 7.5-minute series and distributed 37 different maps to appropriate Federal, State, and local agencies as required under an agreement with the USGS.

A satellite Image Map of Illinois made from the new high-resolution, Thematic Mapper satellite images is being planned as a joint project of the State Geological Survey and Northern Illinois University. This will be the first mosaic of satellite images of Illinois. The mosaic will be of considerable use to scientists, educators, engineers and businessmen for technical work, planning, and education.

GEOPHYSICAL INVESTIGATIONS

Proposal for Contribution to Continental Reflection Profiling (COCORP) Requesting Deep Seismic Reflection Study in Southern Illinois (Heigold, Schwalb, Nelson, Damberger, and Sargent). Nonproprietary seismic reflection data in southern Illinois is almost nonexistent, yet deep-reflection seismic data are seen as a means of obtaining detailed information about the crust below the sedimentary column. This information is pivotal in the solution of many important, but unsolved, geological and geophysical problems in southern Illinois. This information would also undoubtedly provide stimuli for subsequent research. A proposal calling for more than 300 miles of carefully selected seismic reflection traverses has been written.

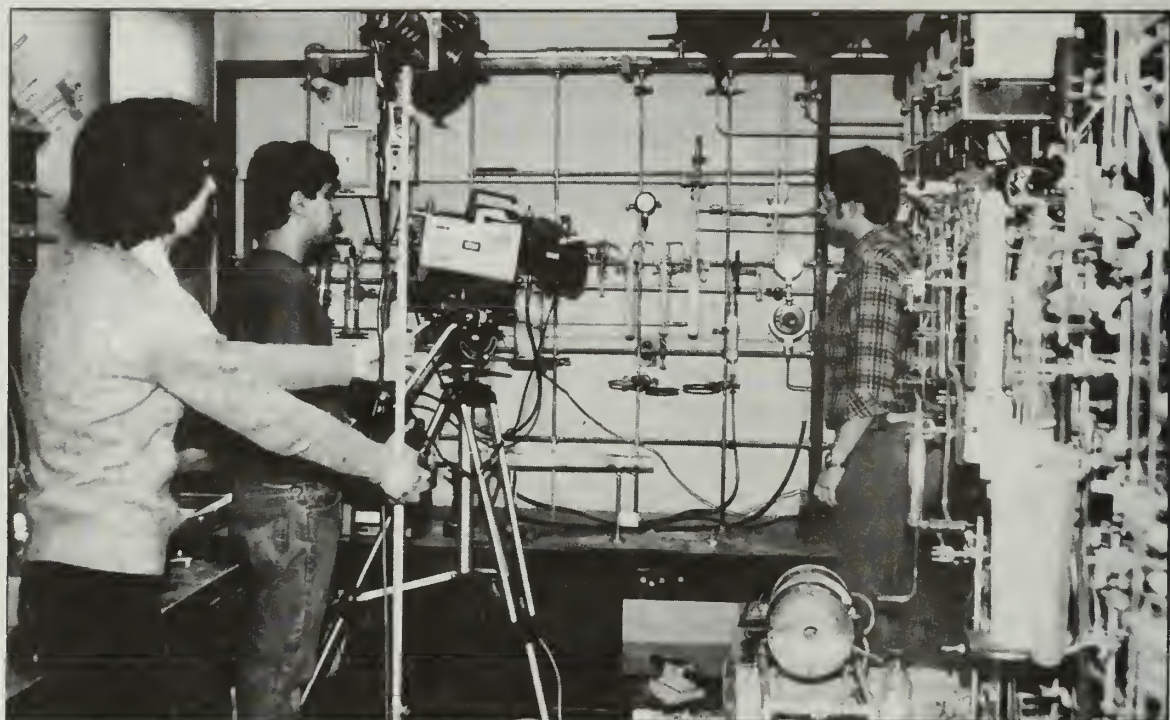
Gravity-Magnetic Investigation

Ground Magnetic Surveying to Determine Trench Boundaries of Waste Disposal Sites (Gilkeson and Heigold). A ground magnetic survey with a portable instrument was conducted at a secure hazardous and chemical waste disposal site located near Wilsonville to define the boundaries of buried disposal trenches. The boundaries of the trenches were not accurately known, and research projects being conducted on the disposal site by the Geological Survey required this information (see Related Projects). An additional reason for the geophysical survey was to evaluate the application of magnetic methods to this specific task and to develop generic methodology for applying magnetometer surveys to other disposal sites.

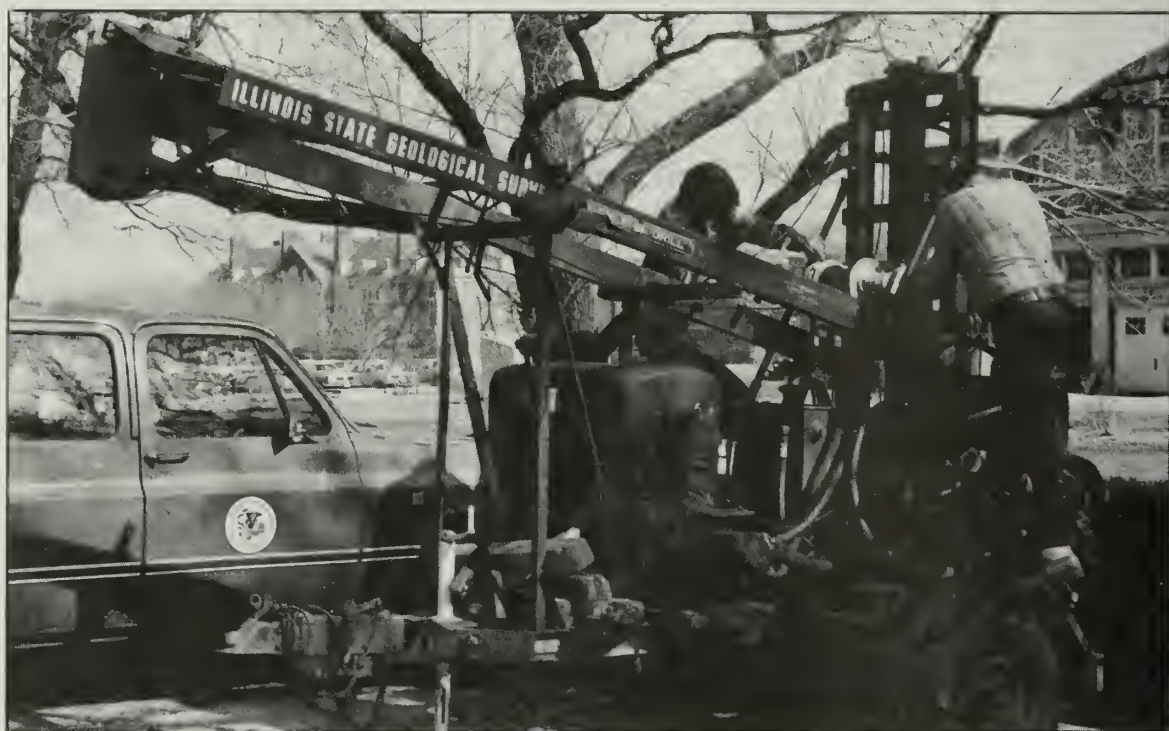
The magnetometer survey defined the location of trenches at Wilsonville with a high degree of accuracy, as shown by field testing and computer modeling. A report on the study presents specific findings for the Wilsonville site, describes methods used for data acquisition and computer modeling, and discusses the broad application of magnetic methods to investigations on disposal sites.

Isotope Geochemistry

Radiocarbon Dating (Liu, Fisher, and Coleman). During the past year, radiocarbon ages were determined for approximately 130 samples. An equal number of $^{13}\text{C}/^{12}\text{C}$ determinations were performed during the same period for isotopic fractionation corrections. Approximately 50 percent of the samples analyzed were paid for with funds from sources outside the Survey. We have not been able to operate to our full capacity because of repeated equipment breakdowns. This situation may produce serious problems in the near future, since the number of samples submitted this year has increased greatly. We anticipate that the sample submission will continue at the rate of 200 samples/year in 1985. To ensure continued operation at this rate, the acquisition of a new scintillation counter seems to be the only logical solution.



Barry Fisher, Analytical and Isotopic Chemistry (right) prepares samples for radiocarbon dating as Gail Gray helps television cameramen with lights.



Continuous wire line sampling equipment, hydraulic winch, and idler recently installed on the Survey's Mobile drill rig, provide continuous cores up to about 50 feet in depth, saving considerable time for Survey staff.

Two ISGS date lists were completed at the end of March 1985. For the first quarter of 1985, the laboratory has been operating at full capacity (approximately 50 radiocarbon age determinations per quarter).

Stable Isotope Ratios as Naturally Occurring Tracers in the Aquaculture Food Web (Coleman, Morin, and Liu with INHS). This joint project with the Natural History Survey, funded by the United States-Israel Binational Agricultural Research Development Fund (BARD), involves the use of natural isotope tracers to evaluate the significance of the available food in an aquaculture system and the effectiveness of certain agricultural wastes as fish foods.

Experiments during 1984 and 1985 have confirmed previous conjecture that tilapia are not purely herbivorous fish but benefit greatly from bacterial development on detrital material. This supports the conjecture that expensive commercial feeds often used for tilapia serve merely as costly substrates for bacterial production; in our experiments, algae served as an inexpensive, natural substrate for bacteria on which young tilapia were found to thrive.

CLAY MINERALOGY

The Origin of Paleozoic Clays in the Illinois Basin (Hughes and Glass). Several lines of investigation are combined in this research aimed at determining whether individual clay minerals are detrital, diagenetic, or authigenic in each of the Paleozoic strata of the Basin. The result should be applicable to oil and gas exploration, coal research, lead-zinc and fluorite research, aquifer studies, investigations of soil formation, and studies on the origin of the strata.

Mineralogy of Clay Partings in Illinois Coals (Hughes, DeMaris, White, and Cowin). The investigation of clays and shales associated with Illinois coals continues at a steady pace. A publication in preparation will summarize the origin and distribution of these materials. Study results show that underclays and partings in coals were soils, but that most of the soil formation in underclays resulted from plant growth before the establishment of the coal-forming swamp. Some underclays and most shales overlying coals are relatively unaltered deposits of detritus. Underclay composition is probably related to contemporaneous channel location, much as low-sulfur coal and nonmarine roof shale are also associated with the channels. The clays may further provide important clues to the origin of pyrite and marcasite that form in coal-bearing strata.

Corrensite from Insoluble Residues of Limestones from Southern Illinois (Baxter, Hughes, and Glass). This study, now completed, showed that the limestone residues contain a suite of corrensite, smectite, illite, and well-crystallized chlorite and kaolinite, adding to our knowledge of the depositional and postdepositional history of the rocks and the region.

Remote Sensing Activities

Remote Sensing Activities (Stohr). The Geological Survey continues to monitor and report on remote sensing activities in Illinois. During the past year the National High Altitude Aerial Photography program completed photography over Illinois, and for the first time this photography was done at the same scale and time of year across the entire continental United States. Furthermore, the photography is "leaf off" and cloudfree, the conditions most useful for geologic, soil, and engineering purposes. Future flights will be made "leaf on" to obtain agricultural crop information.

Side-Looking Airborne Radar (SLAR) imagery collected by the U.S. Geological Survey in December 1984 over the Paducah Quadrangle will become available at the ISGS this summer at a scale of 1:250,000. Radar imaging has also been collected at the Macomb Test Site and in a flight strip over Chester, Illinois. During the reporting year, 24 technical enquiries concerning remote sensing and aerial photography were received at the Survey.

STRATIGRAPHIC INVESTIGATIONS

The Geological Survey has prime responsibility for developing information and reporting on the basic rock units that underlie the state. During the year special emphasis has been placed on deep drill holes and the configuration of igneous rocks that form the deepest basement complex yet reached in Illinois. This study and the study of Cambro-Ordovician rocks that overlie the basement have been part of a nationwide search for strategic and critical minerals funded by the U.S. Geological Survey.

Study of the next younger rocks (of Ordovician and Silurian age) was greatly accelerated in the Upper Illinois Valley area; studies of petroleum-related Silurian, Devonian, and Mississippian subsurface rocks have been ongoing elsewhere, and examination of Quaternary reference sections has continued in parts of northern Illinois.

Quaternary Stratigraphy

Revision of the Wedron Formation and Detailed Study of the Wedron Type Section (Hansel, Follmer, Glass, and H. W. Johnson). A proposal to raise the Woodfordian Wedron Formation to group status and to define formations and members within it has been under study by Quaternarists since 1980. Recent detailed study of the stratigraphy and genesis of deposits at the Wedron type section was begun in June 1983 as part of this effort. At the North Central Section meeting of the Geological Society of America, a field trip, Depositional Environments and Correlation Problems of the Wedron Formation in Northeastern Illinois, was conducted in April 1985.

Yorkville-Wadsworth Till Member Boundary in the Southern Sector of the Joliet Sublobe, Northeastern Illinois (Killey and Glass). This study was also presented at the North-Central GSA meeting in April. Distinct mineralogical units have been traced in the southern boundary area of the Yorkville and Wadsworth Till Members. This study contributes to an understanding of the stratigraphic succession of younger Wedron Formation tills and related units in this area and opens up possibilities for new interpretations of geologic history of the area.

Lake History of the Greater Chicago Area (Hansel, Collinson, and Larsen, USGS). Detailed stratigraphic studies of deposits in the type area (northeast Illinois to northwest Indiana) of glacial Lake Chicago have been undertaken. In the past 36 months the ISGS Isotopic Geochemistry Lab has processed 40 radiocarbon dates on materials collected from shoreline deposits between Kenosha and Gary. These dates make possible an increasingly detailed and revised lake history reconstruction for the Greater Chicago area for the past 12,000 years.

Loess Stratigraphy of the Mississippi Valley (McKay, Follmer, Glass, and B. Miller, LSU; M. Guccione and M. Rutledge, University of Arkansas; and E. Grissinger, University of Mississippi). The purpose of this research is to refine correlation of loess deposits and paleosols of the lower Mississippi valley to the Illinoian and pre-Illinoian deposits in Illinois. Three trips were made to sample Quaternary deposits in exposures along the Mississippi River valley. Analyses of grain size, clay mineral content, and carbonate mineral content have been completed on more than 200 samples. Preliminary indications are that the Loveland Loess of the lower valley is considerably more complex than previously recognized and that part of it may correlate to deposits that are older than the Kansan of Illinois.

Ancient Loess Deposits in Illinois (McKay and Glass). Outcrops that expose Illinoian and older loess deposits were identified and sampled in southwestern Illinois. McKay and H. Canfield of the University of Wisconsin-Madison collected samples for thermoluminescence dating. Results will provide a basis for comparison with dates on similar deposits along the lower Mississippi and Missouri Rivers.

Applications of Clay Mineral Composition in Quaternary Geology (Glass and Killey). Information on clay minerals is important in comprehending the distribution of glacial deposits across the state. Three projects now in progress involve the compilation and presentation of clay mineral data meticulously collected by Glass over the last 30 years. The first project is the development of a state map that will show distinctive and traceable clay mineral units in surface tills across Illinois. The second project will provide a detailed explanation of techniques for sample preparation and quantitative analysis for clay mineral data developed by Glass and used at the Survey for 30 years. The third will describe the principles governing the use of clay mineral data in stratigraphy and include suggestions detailing proper use of the data in stratigraphic interpretations and correlations.

Stratigraphy of Illinoian Glacial Deposits, Southwestern Illinois (McKay, Killey, and Glass). Glacial deposits are being correlated on a continuing basis between localities for which substantial amounts of data are available in order to establish the stratigraphic succession and the composition of individual geologic units. The current study focuses on data assembly and analysis from three benchmark locations: the Wilsonville, Paddock Creek, and Maryville sites in Macoupin and Madison Counties. The study will tie loess units into the till record, providing the means to correlate a previously unrecognized till unit at Paddock Creek, Madison County to the other benchmark locations. The study will be extended across southern Illinois for eventual synthesis into a model of regional distribution of glacial deposits.

Edwards River Valley Soil Geomorphology (Follmer; R. G. Darmody, University of Illinois; and J. W. Scott, Soil Conservation Service). Soil Conservation personnel of Mercer County requested research help for a study of parent material of soils in the county. Unexpected patterns of soil have been found on the valley slopes of the Edwards River. Preliminary studies indicate that the geologic history and a particular set of geomorphic processes explain most of the soil patterns. The main question concerns sandy soils high on the landscape which are eolian in origin. Accurate soil mapping is needed to manage the local problems related to fertility and groundwater contamination.

Sangamon Soil Type Traverse (Follmer and McKay). The Sangamon Soil is the basis for stratigraphically separating deposits of the last glaciation (Wisconsinan) from the previous glaciation (Illinoian). The type area for this unit is in central Illinois, but no type traverse has been designated. We have proposed that the exposure at the Material Service Limestone Quarry north of Athens be chosen. Although some progress has been made on meeting the requirements of full characterization of type section, which includes detailed studies of the geology and pedology, additional work is necessary.

Landscape Scale Interactions in the Vermilion River Basin--
Geomorphological and Hydrological Controls in Stream Productivity (M. J. Wiley, ISNHS; K. Singh, ISWS; and Follmer). The primary goals of this project, which has been submitted as a proposal to the Department of Energy and Natural Resources, is to determine past and present geological, hydrological, and biological characteristics of two river basins (the Middle Fork and Salt Fork of the Vermilion River), which greatly differ from each other. Studies will involve the source and type of sediments, stream hydraulics, dissolved oxygen balance, biological productivity, and overall stream quality.

Late Wisconsinan/Holocene Environments (Follmer and McKay). Two continuous cores of peat and marl were collected with the Geological Survey's Mobile drill in order to study fossil coleopteris (beetle) faunas and other insects. The purpose of this study, undertaken by Dr. Alan Morgan, University of Waterloo, Waterloo, Ontario, is to refine paleoenvironmental reconstructions for the period from about 15,000 years ago to the present.

1985 Friends of the Pleistocene Field Trip Guidebook

Reports of the following studies were prepared as contributions to the field trip guide published in conjunction with the 32nd Midwest Friends of the Pleistocene Field Conference in Rockford, May 1985. The ISGS is hosting this field trip in central-northern Illinois. These studies are outgrowths of geologic work done for the Survey's geology-for-planning study of Boone and Winnebago Counties (ISGS Circular 531).

Winnebago and Glasford Formation Tills at the Nimtz Quarry Section (Berg and Kempton). In this study, the Nimtz Till Member is designated a formal rock-stratigraphic unit, and the Argyle Till Member is formally revised. This identification has helped to unravel the stratigraphic succession of the region. The best exposure of these units is at the Nimtz Quarry Section, just northeast of Rockford. The stratigraphic relations of the Argyle, Nimtz, Oregon, and several other older tills at this exposure are described.

The Rockford Terrace: A Late Illinoian Outwash Deposit (Follmer, Berg, and Masters). The principal objectives of this study were to identify and describe paleosols, ice wedges, and the gravels within the Rockford Terrace, just south of Rockford on the west valley wall of the Rock River. Investigations suggest that the Illinoian-age Argyle Till Member lies beneath the gravels and that the Sangamon Soil has formed in the top of the gravels as well as through numerous ice wedges; therefore, the terrace is Illinoian in age, and probably formed as a result of braided stream outwash from recession of the glacier that deposited the Argyle Till. Large boulders in the terrace suggest propinquity to an ice margin; they also suggest that the terrace may be a kame terrace, eroded kame, or perhaps just a high energy outwash deposit.

Stratigraphic Relationships of the Beaver Creek Sand Member of the Winnebago Formation (Berg and Kempton). A sand and gravel underlying Winnebago Formation tills was delineated and mapped from northeastern Boone County to east-central Winnebago County. Designated in this study as the Beaver Creek Sand Member and given formal rock-stratigraphic status within the Winnebago Formation, the unit forms a potential aquifer where buried and is exposed along valley walls of Beaver Creek and the Rock River. The Beaver Creek Member appears to be a preglacial outwash to the Nimtz Till Member. Although the Beaver Creek Sand is mostly confined to areas overlying the Troy and Rock Bedrock Valleys, it also seems to have spread out over a relatively flat paleo-landscape in northern Boone County. This sand and gravel does not overlie the bedrock high between the Troy and Rock Bedrock Valleys.

Stratigraphy of the Oregon Till Member-silty facies and the Fairdale Till Member (Kempton and Berg). The Oregon and Fairdale Till Members are designated in this study as formal rock-stratigraphic units within the Glasford Formation. These units were previously thought to be units of the Winnebago Formation. The tills are discussed from their occurrences in their type sections.

Stratigraphy of the Capron Till Member, Northern Illinois (Krumm and Berg). A recent refining of stratigraphic relationships in northern Illinois directed attention to the Capron Member and how it relates to the newly defined Quaternary sequence. The Capron had been characterized on the basis of relatively few samples, and one facet of this study was to drill new holes and collect many samples in order to establish the diagnostic characteristics and areal extent of the Capron. The Capron is now known to be extremely variable in texture, but the clay mineral composition is very uniform. Similarities in clay mineral composition and grain size suggest that the Capron is related to a portion of the Clinton Member of south-central Wisconsin.

Stratigraphic Reinterpretation of Tills in North-Central Illinois (Kempton, Berg, and Follmer). This paper discusses the stratigraphic framework around which the geology-for-planning study of Boone and Winnebago Counties was based, focusing on the stratigraphic relationships of 12 tills. An explanation for previous miscorrelation of some of these units is given. Several tills in this region were found to have similar diagnostic characteristics. A comprehensive drilling program with detailed sampling associated with the geology-for-planning study revealed stratigraphic complexities that led to revisions in the placement of Winnebago and Glasford Formation Members. The realization that the Esmond Member was correlative with the Illinoian-age Sterling



William Wescott, Intersurvey Geotechnical Laboratory, obtains data on bulk density of samples by particle size analysis. These data are particularly useful for Quaternary and engineering geology studies.

Member rather than a Wisconsin till was the first step in the stratigraphic revision.

Also discussed in this paper is the designation of the Belvidere, Oregon, and Herbert Till Members as formal rock stratigraphic units. Older Illinoian members, the Kellerville, the Foxhollow (of Wisconsin), and the Ogle, are described. A soil formed into the surface of the Kellerville at several locations and correlated to the Pike Soil of western Illinois was discovered during this study.

Geomorphic Relationships Between a 47,000-Year-Old-Bog and a Paleosol in the Argyle Till (McKenna). This study, completed as a Master's thesis at Northern Illinois University (1984), provides significant information on the glacial history of north-central Illinois.

The Farmdale and Sangamon Soils at the Wempletown Southeast Section, Winnebago County, Illinois (McKenna and Follmer). This recently completed study of a sequence of loesses and paleosols over a glacial till has confirmed several of the revisions of the glacial stratigraphy in north-central Illinois proposed by Kempton, Berg, and Follmer.

Paleozoic Stratigraphy

Geology of the Caseyville and Abbott Formations in the Pounds Escarpment Along I-57 and I-24 (Jacobson). This paper is one of a number of papers prepared by Survey staff to provide significant field stops for the GSA Decade of North American Geology Field Trip Guidebooks.

Classical lower Pennsylvanian fluvial sediments are exposed at this site in some of the best road cuts in the state. Many varieties of sedimentary structures characteristic of fluvial clastic sediments can be observed. Examination of this stop will provide an excellent introduction to the nature of the lower Pennsylvanian of the Illinois Basin. Nowhere else in the Basin are there such complete exposures of the Caseyville and lower Abbott Formations.

Age and Origin of Potassic Metasomatism in Ordovician Tuffs of the Upper Mississippi Valley, U.S.A. (R. L. Hay, University of Illinois; Ming-chou Lee, Case Western Reserve; and Kolata). Silicic vitric tuffs (volcanic ash) altered to K-bentonite and K-feldspar have long been recognized in Champlainian (Middle Ordovician) strata of the Midcontinent United States. This potassic alteration is very likely related to the abundance of authigenic K-feldspar in Cambro-Ordovician rocks of eastern North America. The purpose of this project is to determine how and when the potassic alteration took place. Eleven samples from the Deicke K-bentonite Bed, Spechts Ferry Formation, of the upper Mississippi Valley representing four different size fractions were given potassium-argon dates of 360 to 400 million years. Our present working hypothesis is that the source of the potassium was from hypersaline water that infiltrated the Cambro-Ordovician rocks during the Devonian Period. Results of this study are being prepared for publication.

K-bentonites of the Ordovician Decorah Subgroup, Upper Mississippi Valley: Correlation by Chemical Fingerprinting (Kolata and J. Frost; and W. D. Huff, University of Cincinnati). The 460 million-year-old limestones and shales of the Champlainian (Middle Ordovician) Decorah Subgroup in the Mississippi Valley region contain at least four altered volcanic ash beds (K-bentonites). Because the ash falls occurred in very brief intervals of geologic time, they are essentially contemporaneous throughout their area of distribution and are very useful time-line markers to which geologic events can be referred during preparation of interregional correlation charts and structural geology maps. This study should yield important new information about the depositional and tectonic history of the Midcontinent. Two of the Decorah K-bentonites have been traced, on the basis of trace element chemistry, for a distance of 800 km from St. Paul, Minnesota to Ste. Genevieve, Missouri.

Stratigraphy of Middle Ordovician K-bentonites in the Central and Southern Appalachians (W. D. Huff, University of Cincinnati; and Kolata and J. Frost). This study, an extension of the projects just described, is part of a long-term program to correlate Champlainian (Middle Ordovician) altered volcanic ash beds (K-bentonites) of eastern North America, including Illinois. On January 15, 1985, this project was awarded \$132,000 (over a 3-year period) by the National Science Foundation. Fieldwork is underway and samples are being prepared for chemical analyses at the Illinois State Geological Survey.

Lithofacies Distribution within the Maquoketa Group (Ordovician in Northeastern Illinois) (Graese and Kolata). Recently acquired cores and geophysical logs from test drilling for the proposed 20 TeV proton accelerator have provided much new information on the Cincinnati (late Ordovician) Maquoketa Group in northeastern Illinois. Within this area the Maquoketa consists of biogenic carbonates and shales characterized by complex facies relationships. Cross-sections and fence diagrams reveal thickness, distribution, and character of the various lithologies within the Maquoketa.

Stratigraphy and Depositional Environments of the Carboniferous Fraileys Shale and Haney Limestone in the Illinois Basin (Treworgy). Recognition and mapping of the Fraileys Shale and Haney Limestone and determination of the environments of deposition of the facies will increase understanding of the paleoenvironmental framework of the Illinois Basin for a part of the Carboniferous System.

The lateral distribution patterns of lithofacies in the Fraileys and Haney reveal a positive correlation between lithofacies boundaries and structural features in the Illinois Basin. Shallow-water carbonates and nearshore clastics, including remains of ancient soils, occur along the edge of the Basin on structural shelves. The central part of the Basin was the site of deposition of deeper-water carbonates and distal clastic facies. The transitions between shallow and deeper water deposition correspond with major structural features in the Basin that appear to have been broad hinge lines separating shallow shelf areas from deeper offshore areas. The vertical sequence of lithofacies

reveals several sea-level changes that occurred during deposition of the Fraileys-Haneys interval, including a period of widespread emergence of the Basin's shelf areas.

Text and figures for this study are currently being reviewed for publication.

Tri-State Committee on Correlations in the Pennsylvanian System of the Illinois Basin (Jacobson and Trask). The committee, a long-term cooperative effort of the three State Geological Surveys active in the Illinois Basin coal field, is continuing its efforts to simplify and standardize the stratigraphic nomenclature of the Pennsylvanian System.

A paper that introduces Basin-wide names for five coal seams and two limestone beds was submitted to the Illinois Academy of Science for publication, and the committee is currently evaluating six more units. In June 1984, a field trip was held in southern Illinois, western Kentucky, and southwestern Indiana to investigate the type areas and the stratigraphic problems that exist in the six units.

Subsurface Geology

Knowledge of the subsurface--fundamental to many Survey research projects--is gained through acquisition, preservation, and study of borehole samples, cores, geophysical records, fossil samples, and drillers logs, and sometimes through scouting efforts. To make this valuable material available to the staff and to the public as quickly as possible, new emphasis is being placed on computerizing subsurface files and planning for improved storage efficiency and long-range expansion at the Survey Annex.

Structure and Topography of Precambrian Surface in Illinois (Sargent and Buschbach). A map of the Precambrian surface on a scale of 1:500,000 was completed in February. The Precambrian is known from 32 borings that penetrate from a few feet to more than 3,400 feet into crystalline basement rocks. The borings are distributed among 23 of the 102 counties in the state. Many other deep drill holes provide minimum depths to basement as well as deep control points from which to project estimates. These data were combined with projections from higher surfaces to construct a map intended to be predictive of the Precambrian surface on a regional basis. In the few places where closely spaced basement tests are available, local relief of more than 800 feet is suggested. Phanerozoic rocks on-lap these topographic highs. There is growing interest in the development of storage caverns in these rocks, as well as interest in their structure and tectonic history. Both structure and tectonic history influence the migration of subsurface fluids leading to oil and gas entrapment and mineralization.

Lithofacies and Isopach Mapping of the Sauk Sequence in Illinois (Sargent). The USGS, through its efforts to delineate the status of the strategic and critical minerals in the United States, contracted with

the state surveys in an 11-state region of the midcontinent to construct lithofacies and isopach maps of the Sauk Sequence. Because the basal clastic rocks, represented by the Mt. Simon Sandstone and older strata, are such a massive monolithic unit, they were eliminated so that facies relationships for the remainder of the sequence could be assessed.

Sample studies, core descriptions, and geophysical logs were used to evaluate more than 111,000 feet of stratigraphic section. Thicknesses of the three principal lithologies (limestone, dolomite, and clastics) were determined. Ratios of these lithologies were calculated to classify the facies and plot their areal distribution. In February a 1:500,000-scale facies map was completed.

Implications about Paleozoic Stratigraphy from Recent Deep Drill-holes in Northern Illinois (Sargent). In recent years several deep drillholes have penetrated the entire Phanerozoic section in northern Illinois. Three diamond drill cores were cut in Stephenson County, an oil test was drilled in La Salle County, and a research well was drilled by the USGS in Illinois Beach State Park, Lake County. In addition to providing thickness and lithofacies data on the Sauk Sequence and depths to Precambrian basement, these borings have provided geophysical logs and sample analyses that expand our understanding of deeper strata many tens of miles into previously untested areas. They are 25 to 50 miles from previously existing Illinois basement tests. Results of this study are being combined into a short circular.

The Stratigraphy of the Everton Formation (Ordovician) in Illinois (Norby, Sargent, and Schwalb). Recent investigations of the Illinois Basin have called attention to the need to identify the thickness, extent, lithostratigraphy, and biostratigraphy of the Everton Formation. This formation has generally been included in the Prairie du Chien Group (Canadian Series); however, the Everton is Whiterockian (basal Champlainian) in age.

Only one core is known to penetrate a part of the Everton in Illinois: Superior Oil Company (Ford C-17) in White County. Conodonts from test samples indicate that the basal 175 feet of the core is Whiterockian, therefore Everton Formation. A deep hole in Williamson County is planned for the spring of 1985. Additional drill cuttings from this hole have been requested for conodont dating. These data will facilitate correlation of the Everton and overlying and underlying formations and help resolve the time-stratigraphy boundary at the base of the Everton Formation.

Biostratigraphic Zonation of the Silurian in Central Illinois (Norby, Sargent, and Mikulic). A 4-inch diameter core of the complete Silurian section at the Lincoln Gas Storage Field in Logan County has been crushed for conodont extraction. Although the Ordovician-Silurian contact picked by conodonts agrees with the lithologic description, the recovery of conodonts from the upper part of the core shows that the Silurian-Devonian boundary is somewhat lower than that suggested by the

lithology. Conodonts should provide good biostratigraphic correlation of this central Illinois core to many of the type sections in north-eastern Illinois and to the outcrop areas in western Illinois.

North American Craton in the United States: Chapter 11, The Illinois Basin Region (Collinson, Sargent, and Atherton; and Shaver, Indiana Geological Survey). This report synthesizing information on Illinois Basin development includes thickness and structure maps covering Precambrian through Permian time and information on tectonic episodes, depositional trends, erosional effects, and important resources. The manuscript will appear as a chapter in the Decade of North American Geology series sponsored by the Geological Society of America. Although dormant for months, the project was revived in February. A draft manuscript for review will be available in May.

Subsurface laboratory (Atherton). Dr. Elwood Atherton, Emeritus, supervises the subsurface laboratory and responds to public queries as well as those of the scientific staff. He shares responsibility for critically reviewing Survey manuscripts to ensure compliance with official stratigraphic policy. During the year he reviewed 49 manuscripts and 9 abstracts, and responded to dozens of inquiries on stratigraphic questions. In addition, Dr. Atherton has been active in preparing revisions for the ISGS Stratigraphic Code.

STRUCTURAL GEOLOGY

The Survey's research on the nature of the complex geologic structure of southern Illinois continued at a high level, supported through the New Madrid Seismotectonic Study funded in part by the U.S. Nuclear Regulatory Commission (U.S. NRC).

Structural Geology of Southeastern Illinois and Vicinity (Nelson and Lumm). (ISGS Contract/Grant Report 1984-2, grant no. 1-5-24465 from U.S. NRC). A 125-page report covering the extent, nature, age, and origin of faults and related geologic structures in southeastern Illinois and adjacent parts of Indiana and Kentucky was completed; it presents a tectonic history of the region and evidence for a contemporary stress field believed to be responsible for earthquakes.

Most faults in the region reflect late Paleozoic and Mesozoic reactivation of a Precambrian-Cambrian rift system--the Reelfoot (Embayment) Rift and Rough Creek Graben. Structures include normal faulting under horizontal tension, upthrusting related to vertical uplift or tilting of basement blocks, early Permian ultramafic intrusive and explosive igneous activity, and strike-slip faulting of moderate scale. No evidence was found for Quaternary movement on major bedrock faults. The modern stress regime of horizontal ENE-WSW compression is believed to be responsible for jointing, minor thrust faulting, ground failure in underground mines, and small-to-moderate earthquakes that occur in the region.

Structural Geology of Ste. Genevieve Fault Zone, Illinois and Missouri (Nelson and Lumm). The Ste. Genevieve Fault Zone was developed by two movements, one in late Middle Devonian time, the second in late Mississippian through early Pennsylvanian time. Faults were produced by vertical uplift and tilting of basement blocks. No Quaternary movement is indicated; however, reactivation of faults by a modern stress field appears possible.

A manuscript for the ISGS contract/grant series (the final report for second phase of U.S. Nuclear Regulatory Commission Grant No. 1-5-24465) is in final stages of review.

Thrust Faults in Southern Illinois--Result of Contemporary Stress (Nelson and Bauer). This paper presents evidence that small north-trending thrust faults observed in coal mines are products of a modern ENE-WSW horizontal compressive stress field, which also produces joints, ground failure in mines, and small earthquakes.

A manuscript now being edited will be submitted to Geology, the journal published by the Geological Society of America.



Donald Lumm, Coal Section, explores an abandoned tripoli mine to locate and identify faults and fractures in bedrock as part of a study to delineate southernmost extent of the Ste. Genevieve Fault Zone.

PALEONTOLOGY/PALYNOLOGY

Paleontologic/palynologic studies are basic tools for stratigraphic correlation and interpretation of ancient environments and depositional history. Information resulting from these studies is vital to many Survey programs (particularly coal and oil research) and Survey palynological research on Pennsylvanian coal swamps has contributed greatly to world understanding of the coalification process in peat bogs and coal swamps.

Seven scientists, all of whom have other major responsibilities, contribute to the programs. Dr. Peppers supervises the Palynological Laboratory, the only such laboratory in the central United States that routinely provides age determinations and correlations of Pennsylvanian strata (particularly coal-bearing strata). Most of the 90 coal beds in Illinois can be identified and correlated by palynological means.

Dr. Norby supervises the Conodont Laboratory and Acid Digestion Laboratory. Conodont studies furnish important evidence for correlating Paleozoic rocks; recently, conodonts were used to provide geologic ages for important drill cores from deep in the Illinois Basin. Conodonts also provide Thermal Index values, a measure of temperatures to which the rocks have been subjected during the generation and preservation of hydrocarbons.

Dr. Baxter supervises the Foraminiferal Research Laboratory, which provides additional means of correlating late Paleozoic rocks (Foraminifera are especially useful for studying carbonate environments); Dr. Kent, who curates the Geological Survey Paleontologic Collection, makes loans, borrows material, and prepares catalogs that are widely used; Dr. Kolata specializes in the study of Ordovician echinoderms; Dr. Mikulic studies early Paleozoic arthropods; and Dr. Collinson specializes in Devonian-Mississippian invertebrates and conodonts.

Palynological Studies

Paleocology of Pennsylvanian Coal-Swamp Flora (Peppers, Philips, University of Illinois; and DeMichele, University of Washington). During the report period, a manuscript entitled "Stratigraphic and Interregional Changes in Pennsylvanian Coal-Swamp Vegetation: Environmental Inferences" was prepared and published and another paper, an extension of the same study, was submitted for publication in the International Journal of Coal Geology. This paper, the most extensive compilation available of paleoecological information on Pennsylvanian coal swamp floras in North America, is based on palynological and coal-ball studies. Although the Illinois Basin was the focal point of the study, paleobotanical studies of coal from other areas were used to extend the data base, allowing extrapolation into and from the Illinois Basin.

The paper includes the first palynological correlation between Illinois Basin and eastern Kentucky coals of the lower part of the

Pennsylvanian System, and illustrates by use of palynology the major and sudden change in coal swamp floras at the Desmoinesian-Missourian boundary in North America (including Illinois) and the Westphalian-Stephanian boundary in Europe. Also included is the first record of spore diversity in coals through the Pennsylvanian. A map shows the abundance of the spore Lycospora associated with the Galatia River, which flowed through the Springfield (No. 5) Coal swamp. The maximum distribution of lycopod trees parallels the distribution of thickest coal deposits.

Palynological Correlations of Major Pennsylvanian (Upper Carboniferous) Time-stratigraphic Boundaries in the Illinois Basin with Those in Other Coal Region of Euramerica (Peppers and Lowry). Major time-stratigraphic boundaries discussed are the Midcontinent Series, the European Series, the divisions in the Soviet Union, and the Lower, Middle, and Upper Pennsylvanian Series as used by the U.S. Geological Survey. The Midcontinent Series is formally recognized and used by the Illinois Geological Survey. The European system of time-stratigraphic classification is considered the standard reference for rocks of this age, and this study should lead to its greater use in the Illinois Basin. This publication presents the first palynology-based correlation of Carboniferous strata in the Illinois Basin and in the Soviet Union.

The possible causes for the major and sudden change in coal swamp flora at the Desmoinesian-Missouri boundary include a change to more seasonal variation in moisture availability due to changes in ocean current and atmospheric circulation. Latitudinal changes in position of the land masses and tectonic uplift of the Appalachian Range may have been factors. The beginning of a long period of stability in polar magnetic reversals began at about the Desmoinesian-Missourian boundary; the CO₂ content in the atmosphere reached a temporary minimum, and major continental glaciation also occurred at the boundary. This project, begun during the last report period, is now nearing completion.

Correlation of Bidwell and Delwood Coal Members (Peppers). Preliminary palynological studies have indicated that the Bidwell Coal in Indiana, considered to be in the lower part of the Spoon Formation, and the Delwood Coal in Illinois, assigned by J. M. Weller (1940) to the upper part of the Abbott Formation, are actually equivalent. Spore analyses are being tabulated so that this correlation can be documented; if it can, the boundary between the two formations will have to be adjusted. Coals probably equivalent to the Bidwell Coal in Indiana and western Kentucky are being re-examined. This coal probably is more extensive and reaches minable thickness over larger areas than previously thought. At some localities, the coal could be considered a boghead coal because it contains the remains of fresh water algae. Continued geologic mapping (COGEOMAP) will help resolve the identification and correlation of these coal seams.

Desmoinesian-Missourian Boundary in the Midcontinent (Peppers and Lowry). A study of coals in the region of the Desmoinesian and Missourian Series type area is continued intermittently. Since the Midcon-

tinent Series classification is used in Illinois, it is worthwhile to compare the palynology of coals in the type area with that from coals in Illinois. This boundary marks the most important change in coal-swamp floras in the Pennsylvanian of North America. This work is being done in association with Dr. Phillip Heckel (University of Iowa), who is heading a team concentrating on the stratigraphy of this part of the Pennsylvanian. Heckel and Peppers are members of the Working Group on the Atokan and Desmoinesian Series (see Other Activities), and study findings will be useful in the objectives of the Subcommittee.

Taxonomic Status of *Granasporites irregularis* (R. Raun, Sohio Oil Co.; M. A. Butterworth, Great Britain; T. L. Phillips, University of Illinois; and Peppers). This cooperative study is concerned with redescribing *Granasporites irregularis* and clearing up synonymy with two other taxa. This species is one of the most abundant spores in the Pennsylvanian of North America and Carboniferous of Europe; however, different names have been used in the two regions, making its use in correlation difficult. A paper is being prepared for publication.

Other Activities (Peppers and Lowry). During the report period, 68 coal samples were processed, most for routine identifications or specific research projects; the remainder, involving correlations of coals, were added to our reference collection.

A short report on palynological correlations of coals in the Abbott Formation in Illinois and the Tradewater Formation in western Kentucky was prepared in cooperation with Dr. T. Kehn of the U.S. Geological Survey. Kehn was extensively involved with the geologic mapping program of Kentucky by the USGS, completed about 6 years ago. USGS palynological investigations were used to help correlate a number of coals and marker limestone beds from one quadrangle to another in West Kentucky and into Illinois.

Palynological analyses are being made on coal samples collected by geologists mapping in southern Illinois as part of the Quadrangle Mapping Project (COGEOMAP). Many of the coals in the lower part of the Pennsylvanian are difficult to trace because they are interrupted by sandstones, and these studies help identify and correlate them.

Several coal samples from near the base of the Pennsylvanian in Rock Island County were analyzed and age determinations were provided in conjunction with the work of Dr. Richard Leary (Illinois State Museum) on the paleobotany and Mississippian-Pennsylvanian erosional contact in that part of the state. In addition, about 40 photomicrographs of spores, along with identification and other data, were provided to Dr. Alfred Traverse of Pennsylvania State University, who is preparing a textbook on palynology. Assistance was given to several graduate students who are doing research in palynology.

Macropaleontology

Paleobiology of the Cornute and Mitrate Carpoids (Kolata). Carpoids are a very rare, enigmatic, extinct group of echinoderms known from Cambrian to Devonian rocks throughout the world. Some of the best preserved specimens in the world occur in Cambro-Ordovician rocks in Illinois and adjacent states and some of the finest specimens are in the paleontological collections of the ISGS. In addition, much new material has been obtained recently from museums in North America, Europe, and Australia, and long-term studies are being conducted on the functional morphology, phylogeny, evolution, and systematics of these carpoids.

Micropaleontology

Skeletal Apparatuses of Conodont Organisms (Norby). Individual skeletal elements of various Chesterian conodont biostratigraphic index species have been related to the whole organism, and identification of any skeletal element now permits recognition of the whole species. The skeletal elements appear in various reoccurring patterns, providing an indication of their arrangement within the conodont animal. Several viable hypotheses of their function within the conodont animal have been analyzed and will be discussed in a paper to be given in Nottingham, England in the summer of 1985.

Silurian Conodont Succession in Western Illinois (Norby and Sargent). As part of the reorganization of Silurian biostratigraphic research, a study of Silurian conodont successions begun by Matthew Avcin early in the past decade has been revived. Some faunas are already in hand and many of the outcrops have been described. This study should provide precise correlation of a core in Logan County to outcrop sections in northeastern Illinois. Understanding of stratigraphic wedge-outs in western Illinois is another important goal of this study.

Paleontological Repository (Kent). The Paleontological Repository contains the fossils and locality descriptions collected and studied by the staff, and by other scholars. Eighty-one formally cataloged and curated Survey collections, dozens of uncataloged field collections, and several reference collections of international significance are in the Repository.

Linesley-Kessling, Subsurface Coral Collection from East-Central Illinois (Kent). A large collection of nearly 100 type, figured, and reference coral specimens was returned from the University of Michigan Museum of Paleontology. Collected from the Middle Devonian Grand Tower Formation in the Herkimer No. 5 Well of Coles County, this collection was studied, relabeled, and cataloged.

Conodont Collection from the Chappel Limestone of Texas (Kent). Borrowed last year by the Amoco Production Research Laboratory of Tulsa, this very large uncataloged collection was returned in December and subsequently curated and labeled.

Gift from Christina Strimple (Kent). Christina Strimple, wife of the recently deceased paleontologist, Harrell Strimple, presented the Geological Survey with a limestone slab containing nine specimens of Scalenocystites strimplei Kolata, a middle Ordovician belemnocystid carpod named by Kolata in 1973. The slab is unique in its state of preservation and number of specimens.

COMPUTER RESEARCH AND SERVICE

Many research projects described in this Annual Report require electronic data processing support. Hardware capabilities of the Survey include a 11/34 minicomputer, digitizer, and plotter; the ISGS programmers develop the necessary software. The Survey also has access to the Prime 750 at the Natural History Survey and to the IBM 4341 and Cyber systems at the University of Illinois through the RJE (remote job entry) station. In addition to supporting the scientific staff, the Computer Unit develops methods that enable Survey activities to be conducted more effectively and efficiently.

Automation of Geological Records Data Handling (Denhart). The present system of gathering, sorting, processing, and typing data within the Geological Records Unit is repetitious and slow, and efforts to design and implement an automated procedure on the Prime 750 to replace this manual system are well under way. About one-third of the system is automated and in use.

Service Activities

Programs and techniques developed to support Survey research are often useful to other organizations in and out of the state. More than 65 copies of ILLIMAP have been furnished to groups outside the Survey; this generates many calls for assistance. Other programs for which requests are received include ISGS digitizing programs and routines for the conversion of X-Y coordinates from one mapping system to another. Support is also provided to other state agencies and University of Illinois researchers when they need Survey expertise or use of our special equipment (the digitizer and plotter are shared when not required for Survey work).

ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES



Artists in the Publications, Graphics, and Photography Unit produce a wide variety of materials ranging from large, complex color maps, illustrations for ISGS publications, poster presentations and slides to charts, signs and forms.



Gerry Glogowski, new head of the Administrative Services Group, meets regularly with heads of administrative units.

ADMINISTRATIVE AND SCIENTIFIC SUPPORT SERVICES

Support services include supplying library references and information; receiving and distributing incoming mail, commodities, and equipment; processing and shipping outgoing orders for publications, maps, and other materials; maintaining the telephone switchboard and information office, conducting public field trips, dealing with a variety of inquiries, distributing educational materials, and overseeing press relations; fabricating, maintaining, and repairing scientific, office, automotive, and other equipment and instruments; supervising the word processing system; providing editorial, graphics arts, typography and publications services.

PUBLICATIONS, GRAPHICS, AND PHOTOGRAPHY UNIT

Clear, accurate, and attractive scientific reports are the primary products of the Publications, Graphics, and Photography Unit. In 1985, a new series was initiated: Illinois Scientific Surveys Joint Report. All three Surveys participate in preparing and publishing this series.

Other major publication projects include state maps, poster sessions (graphics plus text), and speech/slide presentations. The staff also prepares brochures, in-house forms, lists, and signs; edits abstracts, papers, speeches, proposals, ad copy, and special reports for affiliated agencies; and assists scientists at early stages in the preparation of data for written or graphic presentation.

Publications projects completed from May 1984 through April 1985 are listed in the following pages.

<u>Major Publications Projects</u>	<u>1982-83</u>	<u>1983-84</u>	<u>1984-85</u>
Circulars	5	1	4
Bulletins	0	0	0
Illinois Mineral Notes	4	2	2
Environmental Geology Notes	2	2	6
Illinois Petroleum	1	1	1
Reports of Investigations	0	0	0
Contract/Grant Reports	5	5	3
Field Trip Guide Leaflets	4	3	2
Guidebooks	1	0	3
Cooperative Groundwater Reports	1	1	0
IL Scientific Surveys Joint Report			1
Reprints	9	12	11
Abstracts	25	29	35
Papers	41	13	37
Oil and Gas Drilling Reports	12	12	12
Poster sessions	7	8	7
Large plates	18	15	16
Brochures			2
Special reports, proposals, misc.			16
TOTALS	<u>135</u>	<u>104</u>	<u>158</u>

The number of projects completed does not, of course, indicate the magnitude or complexity of individual projects.

During the preceding year, the staff of the Publications Unit consisted of 3 editors, 2 to 3 graphics artists, 1 typographer (since July 1984), and 1 photographer.

Survey Publications Completed May 1984 through April 1985

Circulars

- 531. Geology for Planning in Boone and Winnebago Counties. R. C. Berg, J. P. Kempton, and A. N. Stecyk. 69 p., 21 figs., 7 tables, 3 plates. (3000)
- 532. Potential for Contamination of Shallow Aquifers in Illinois. R. C. Berg, J. P. Kempton, and K. Cartwright. 30 p., 12 figs., 2 tables, 2 plates. (4000)
- 533. An Electrical Earth Resistivity Survey of the Macon-Taylorville Ridged-Drift Aquifer. P. C. Heigold, V. L. Poole, K. Cartwright, and R. H. Gilkeson. 23 p., 30 figs. (2000)
- 536. Coal Resources of Grundy, La Salle, and Livingston Counties, Illinois. 58 p., 30 figs., 10 tables, 6 plates. (2000; in press)

Illinois Mineral Notes

- 89. Directory of Illinois Stone, Sand and Gravel Producers 1983. I. E. Samson. 161 p. (500)
- 90. The Lime and Limestone Market for Sulfur Removal: Potential for 1992. S. B. Bhagwat. 13 p., 6 figs., 5 tables. (1500)
- 91. Removal of Sulfur from Illinois Coals via Charring and Partial Oxidation. R. R. Ruch, C. Chaven, and C. W. Kruse. 30 p., 8 figs., 8 tables. (1500; in press)

Environmental Geology Notes

- 106. Collection of Representative Coal Refuse Samples for Leachate Generation Studies. I. G. Krapac, C. A. Smyth, and R. A. Griffin. 68 p., 9 figs., 23 tables. (1500)
- 107. Geochemical Properties of Coal Wastes and the Toxicological Effects on Aquatic Life. W. R. Roy, T. M. Skelly, I. G. Krapac, R. A. Griffin, D. R. Dickerson, R. M. Schuller, J. J. Suloway, and N. F. Shimp. 124 p., 20 figs., 38 tables. (2000)

108. Supplemental Groundwater Supplies for Six Small Communities in Illinois. V. L. Poole and R. Vaiden. 34 p., 26 figs. (2000)
109. Messbauer Analysis of Lewisville, Texas, Archaeological Site Lignite and Hearth Samples. R. Shiley, C. Hinckley, R. Cahill, K. Konopka, G. Smith, and M. Saporoschenko. 11 p., 2 figs., 5 tables. (1500)
110. 20 TeV Accelerator in Illinois: Preliminary Geological Feasibility Study. J. P. Kempton, R. C. Vaiden, D. R. Kolata, P. B. DuMontelle, M. M. Killey, and R. A. Bauer (ISGS); J. Lach, S. E. Baker, L. V. Coulson, A. J. Elwyn, R. Stefanski, and E. Treadwell (Fermilab). 75 p., 36 figs., 6 tables. (3000; in press)
111. Sources of Information on Engineering Geology and Related Topics for Northeastern Illinois. ISGS, Illinois Section - American Society of Civil Engineers, and North Central Section - Association of Engineering Geologists. 20 p. (700; in press)

Illinois Petroleum

126. Petroleum Industry in Illinois. 1983. J. Van Den Berg and J. R. Elyn. 140 p., 2 figs., 15 tables. (1500; in press)

Contract/Grant Reports

- 1984-1. Recent Compilations of Coal Resource Data for Federal Lands in Illinois. J. D. Treworgy and M. H. Bargh. 25 p., 10 figs., 2 tables. (50)
- 1984-2. Structural Geology of Southeastern Illinois and Vicinity. W. J. Nelson and D. K. Lumm. 127 p., 48 figs., 3 plates. (500)
- 1984-3. Radioactive Sulfur Tracer Study of Sulfur Removal in the Charring of Illinois Coals at 650°C. J. K. Frost, F. Auteri, and R. R. Ruch. 24 p., 10 figs., 5 tables. (500)

Guidebooks

16. Depositional Environments and Correlation Problems of the Wedron Formation (Wisconsinan), Northeastern Illinois. W. H. Johnson, A. K. Hansel, B. J. Socha, L. R. Follmer, and J. M. Masters. 91 p., 27 figs., 6 tables. (1500)
17. Silurian Geology of the Des Plaines River Valley--Northern Illinois. D. G. Mikulic, R. D. Norby, M. L. Sargent, and D. R. Kolata. 55 p., 22 figs. (1500)

18. Illinoian and Wisconsinan Stratigraphy and Environments in Northern Illinois: The Altonian Revised. Midwest Friends of the Pleistocene 32nd Field Conference. J. P. Kempton, R. C. Berg, D. P. McKenna, E. D. McKay, H. E. Canfield, D. M. Mickelson, J. M. Masters, R. J. Krumm, L. R. Follmer, R. L. Meyers, and J. E. King. 125 p., 50 figs. (2000; in press)

Illinois Scientific Survey Joint Reports

1. Conceptual Models of Erosion and Sedimentation in Illinois. N. G. Bhowmik, M. Demissie, D. T. Soong, A. Klock, N. R. Black, D. L. Gross, T. W. Sipe, and P. G. Risser. Volume 1: Project Summary. 31 p., 11 figs. (2350); Volume 2: Level II Models, Model Interactions, Keywords, and Bibliography. 368 p. (700)

Educational Extension Materials

Educational Resources Booklet. D. L. Reinertsen.

- 1984A. A Guide to the Geology of the Greenville Area. D. L. Reinertsen.
- 1984C. A Guide to the Geology of the Pontiac-Streator Area. D. L. Reinertsen.

Reprints

- 1984G. Memorial to George Miller Wilson. J. A. Simon.
- 1984H. Coal Characterization. H. H. Damberger, R. D. Harvey, R. R. Ruch, and J. Thomas, Jr.
- 1984I. Composition and Distribution of Mineral Matter in the Herrin Coal of the Illinois Basin. C.-L. Chou and R. D. Harvey.
- 1984J. Mineral Matter and Trace Elements in the Herrin and Springfield Coals, Illinois Basin Coal Field. R. D. Harvey, R. A. Cahill, C.-L. Chou, and J. D. Steele.
- 1984K. Three-Dimensional Geologic Mapping: A Basis for Hydrogeologic and Land-Use Evaluations. J. P. Kempton and K. Cartwright.
- 1985A. Economic and Regulatory Framework for Production of Solid Compliance Fuels from Medium to High Sulfur Coal. S. B. Bhagwat and L. A. Johnson.
- 1985B. Comparison of Miospore Assemblages in the Pennsylvanian System of the Illinois Basin with Those in the Upper Carboniferous of Western Europe. R. A. Peppers.

- 1985C. Soil--An Uncertain Medium for Waste Disposal. L. R. Follmer.
- 1985D. A Method for Describing and Evaluating Coal Mine Wastes for Coal Recovery: A Case History from the Historical Longwall District in the Northeastern Illinois Coal Field. L. A. Khan and D. J. Berggren.
- 1985E. Use of Aerial Photographs and Vegetation Patterns to Predict the Distribution of Fine-Grained Quartz and Kaolinite in Tailing Ponds. L. A. Khan, D. J. Berggren, and R. E. Hughes.
- 1985F. Effects of Weathering on Coal and Its Sulfur Constituents in Refuse Piles. L. A. Khan, D. J. Berggren, and R. E. Hughes.

Other Publications and Reports

Oil and Gas Drilling Reports. J. Van Den Berg. May 1984 through April 1985.

Map: Potential for Contamination of Shallow Aquifers from Land Burial of Municipal Wastes in Illinois. R. C. Berg, J. P. Kempton, and K. Cartwright. 30 x 50 inches. Color.

Graphics and Typesetting

<u>Drafting</u>	<u>No. of items</u>
Slide copy: maps, figures, graphs, charts, diagrams, etc.	364
ISGS publications and posters: maps, figures, cross sections, etc.	500
Miscellaneous projects	402
Large plates	16
Covers for publications	29
<u>Typesetting</u>	<u>No. of pages</u>
Slide copy	233
Text, tables, forms, charts, etc.	1,797

Survey Publications in Preparation

Circulars

534. Landslide Inventory of Illinois. M. M. Killey, J. K. Hines, and P. B. DuMontelle. 32 p., 28 figs., 2 tables. (2500)
535. Glaciation and Origin of the Geest in the Driftless Area of Northeastern Illinois. H. B. Willman, H. D. Glass, and J. C. Frye. 65 p., 13 figs., 7 tables. (2000)

Illinois Mineral Notes

A Preliminary Evaluation of Wastes from Coal Mines from the Longwall Mining District for Secondary Recovery of Coal. L. A. Khan, D. J. Berggren, and L. Camp. 36 p., 7 figs. (1500)

Environmental Geology Notes

Southern Lake Michigan: Evidence for Holocene Lake Level Fluctuations. C. Larsen and A. Hansel. 34 p., 11 figs., 2 tables, 1 app. (2000)

Characteristics and Potential Uses of Historic Longwall Mining Sites, North-Central Illinois. S. C. Bradford, D. J. Berggren, and P. B. DuMontelle. 24 p., 22 figs. (2000)

Contract/Grant Reports

Chemical Composition and Geochemistry of the New Albany Shale Group (Devonian-Mississippian) in Illinois. J. K. Frost, D. L. Zierath, and N. F. Shimp. 75 p., 16 figs., 15 tables, 3 apps. (300)

Geophysical Studies at Sheffield. P. C. Heigold and T. H. Larson.

Size and Maceral Distribution of Sulfide Grains in Illinois Coals and Their Washed Products. R. D. Harvey and P. J. DeMaris. 20 p., 15 figs., 6 tables, 1 app. (200)

Reproductions

The Publications Unit duplicates materials for publications, talks, and exhibits, using an Ozalid copier as well as photographic techniques. Services performed by the various duplicating processes are estimated in the following lists.



Madalene Tierney (left) and Margo Rathke helped mail out more than 10,765 publications and 18,219 maps during the reporting year, filling more than 5,000 individual orders.



Marilynn Farnham (left) and Joyce Hurley, information Office, not only cover the switchboard but field hundreds of questions from persons seeking maps, publications, or general information about Survey activities and services.

<u>Photography</u>	<u>1983-84</u>	<u>1984-85</u>
2 x 2 inch slides: color	2,284	1,380
blue foil	(total)	1,411
duplicates		891
PMT prints developed for staff		5,211
Prints made	2,884	2,702
Portraits taken	36	14
Color prints made	15	18
Mylars made	153	123
Black/white developed for staff (35 mm)		39 rolls
Color film developed for staff (35 mm)		142 rolls

Ozalid

<u>Division by Groups and Sections</u>	<u>Number of Copies Made</u>	
	<u>1983-1984</u>	<u>1984-1985</u>

Information & Technical Services:

Oil and Gas Development	4,889	4,268
IL Coal Mines	820	1,156
Coal Structure	555	412
Other	156	82
TOTAL	6,420	5,918

	<u>1983-1984</u>		<u>1984-1985</u>	
	<u>Mylar</u>	<u>Paper</u>	<u>Mylar</u>	<u>Paper</u>
Coal	387	921	83	77
Groundwater	36	114	16	92
Oil and Gas	--	148	5	107
Engineering Geology	--	24	18	67
Stratigraphy and Areal Geology	39	48	64	25
Administrative Services	3	42	40	62
Industrial Minerals	--	7	5	14
Geological Records	--	43	--	59
		1,347		503
GRAND TOTAL	465	7,767	231	6,421

Days of operation of Ozalid Room	58 1/2	52
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INFORMATION AND TECHNICAL SERVICES UNIT

Information Office

Many people visit, telephone, or write to the Survey seeking maps, publications and answers to questions. To meet the needs of the public, the Survey maintains an Information Office where routine questions are answered and publications and maps are sold.

During January and February 1985, more than 400 people purchased maps and publications from this office; this sample suggests that more than 2,400 customers will be served by the end of the year. The Information Office also handled about 800 mail orders and 200 phone orders.

During the 2-month period, the Switchboard received approximately 7,000 incoming calls; this projects to a yearly total of 42,000 calls.

Mail Room

The Mail Room is the central distribution center for all publications and maps of the Geological Survey. Stocks of all in-print publications are maintained to fill mail orders and distribute to Survey staff as needed. The Mail Room also maintains a stock room for all office supplies required by the Survey staff.

Maps and publications distributed during the reporting period:

ISGS Publications	10,765
ISGS Maps	2,738
USGS Maps	11,216
ISGS Blue Line Maps	4,265

Postage Meter

Individual pieces run through machine - 52,152
Amount of postage used - \$14,374.35

Individual Orders Filled

May 1984	- 410	November 1984	- 336
June 1984	- 418	December 1984	- 391
July 1984	- 366	January 1985	- 539
August 1984	- 476	February 1985	- 523
September 1984	- 399	March 1985	- 420
October 1984	- 351	April 1985	- 420

TOTAL - 5,049

Duplicating Services

Number of plates run - 2,023
Number of impressions - 1,910,586

Well Log Copying Service

On June 1, 1984, the Survey began copying well log records requested by customers in person, by mail, or by telephone. Approximately 1,911 orders have been processed since June 1, 1984, resulting in the reproduction of 10,213 logs, 44,742 single data sheets, 100 logs for wells greater than 6,000 feet deep, and 648 parts of logs.

WORD PROCESSING CENTER

The Word Processing Center serves the entire Survey by supervising the operation and maintenance of the word processor and by providing expert operators to enter documents.

Since January 1985, the NBI System 64 was upgraded to 60 megabytes of memory and to 16 ports. The system now includes 7 workstations (one a standalone) and 4 printers. An upgrade of the software program called the system news allows all NBI users to view the system for any messages. Three people were trained at NBI (The Office Design) during the reporting period.

The Word Processing and Computer Committees continue to coordinate efforts to provide greater access to word processing capability for the scientific staff.

TECHNICAL RECORDS OFFICE

The Technical Records Office is a library of Survey correspondence: copies of almost all outgoing correspondence are filed by subject and are cross-referenced with a card index. Technical Records also opens and routes incoming mail to the appropriate person or office. Payments received in the mail are logged and given to the Information Office for further processing. Incoming payments have increased substantially since the inception of the Natural Resources Information Fund on July 1, 1984.

Based on a two-month sample, the following mail count is projected for this reporting period: pieces of mail handled, 206,886; mail returned for central filing, 24,468; items received for the library, 7,056.

TECHNICAL DESIGN, OPERATIONS AND MAINTENANCE

The Technical Design, Operations and Maintenance shops provide many special services for the Survey that would otherwise have to be handled through external contractual services. Survey shop personnel install and maintain the air conditioners; repair, install, maintain, and move office, laboratory furniture, and fixtures; unclog and repair drains, and care for all parts of the Survey's laboratories and offices that are not property of the University.

Shop personnel also provide custom fabrication of laboratory, field, and scientific office equipment and furniture. During the reporting period the staff completed noteworthy jobs:

- Removed laboratory benches, fixtures, sinks in several laboratories and converted them to other uses.



Dennis Reed (right) and Larry Ritchie, with help from other members of the Information and Technical Services staff, produce a wide range of ISGS publications, reports, forms, and other materials.



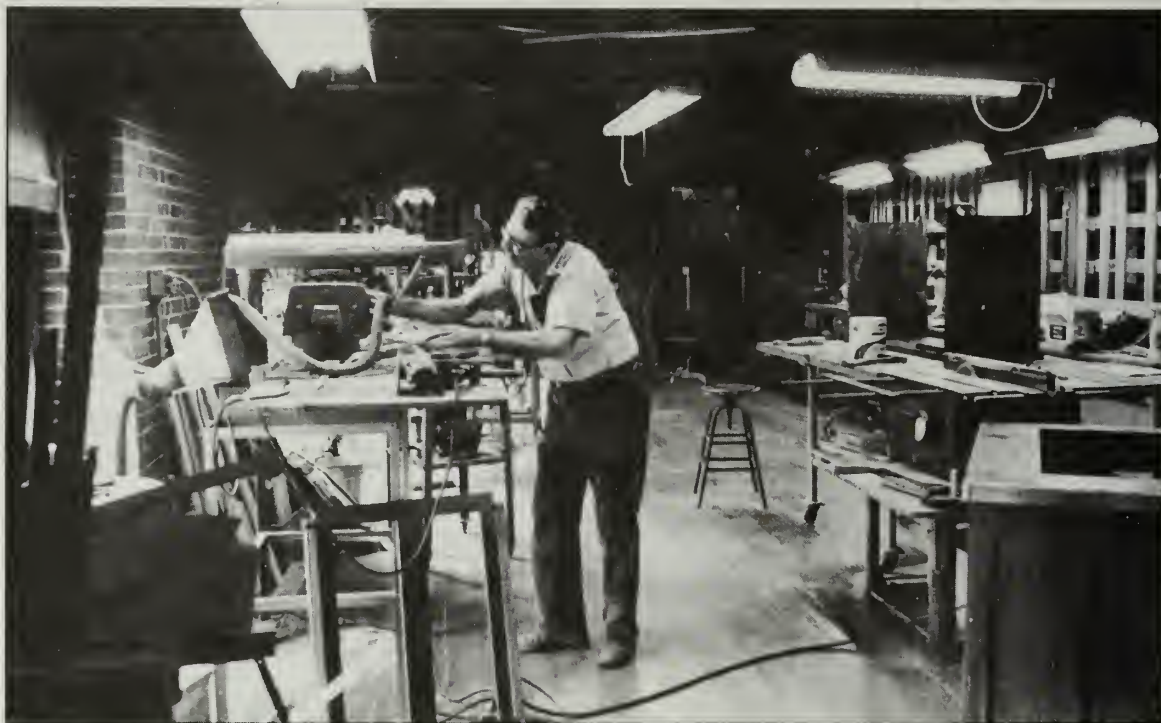
Linda Cunningham, one of the expert word processor operators at the Survey, did the final typing and formatting for this Annual Report. The Survey's word processor system now includes seven work stations and four printers.

- Designed and fabricated two special desk top personal computer security cabinets.
- Designed and fabricated five special roll around, hinged, computer cabinets.
- Designed, shaped, and mitered several large map frames, installed maps, and hung them on office walls.
- Dismantled a dark room on first floor, then painted and converted it into a well log copying room.
- Designed and fabricated a sound deadening cover for a word processor printer at considerable savings over a comparable commercial cover.
- Designed and fabricated a sound deadening cover for the digital plotter printer used in conjunction with the PDP 11/34 in Computer Services.
- Scrounged, cleaned, repaired, painted, and installed a vent hood and bench in Room 435.
- Fabricated a backing board and mounted large pressure gauge equipment attached to the wall in Room 435.
- Assisted in setting up the inter-Survey microparticle-size laboratory at the Annex by moving, modifying, and fabricating equipment.
- Machined and fabricated a strain measuring device used in the field to study the expansion of core and in the laboratory to measure strain in deformation of rock.
- Machined a sample spacer and load bearing for a direct shear device for the Engineering Geology Section.
- Installed continuous wire line sampling equipment, hydraulic winch, and overhead idler pullies on the mobile drill rig.

During the reporting period, 245 repair, fabrication, and maintenance jobs covered by internal work orders were completed. These numbers do not include or reflect the many other jobs done by verbal request, notes, and the regular maintenance procedures that are interspersed with the more specialized shop work.

Electronics Shop

During this period the Electronics Shop processed 62 formal work orders and 178 verbal requests for services. The following illustrates the scope and variety of work accomplished:



Ernest Adair (above) and Phil Williams (below) are valuable members of the versatile shop team that designs and fabricates specialized scientific equipment and furniture, and maintains and repairs office, automotive, and other equipment.



- Installed 11 communications lines from various rooms to the DEC PDP 11/34 and Prime computers. Installed 5 coaxial cables from the NBI Word Processor to various work stations and printers.
- Repaired several video terminals and made cables and adapters to connect a number of terminals to other devices.
- Completed a major rewiring of faulty wiring on the rock drying oven at the Annex. Troubleshooting of the "Big Joe" electric fork lift resulted in replacement of the fork lift's battery and adjustment of the charger to properly recharge the new battery. Also modified and repaired the controller for the hydrometer bath.
- Completed wiring and installation of 2 controllers and power electronics for the Fluidized Bed Unit and the Fisher Assey Furnace at the Applied Lab. Repaired the display electronics on the Calimeter Unit.
- Completed extensive maintenance, repair, and modifications on the downhole logger unit in Vehicle #14.
- Replaced defective and obsolete display tubes on the Neutron Activation Analysis equipment with solid state L.E.D. display units.
- Designed and constructed a signal conditioner module to interface several transducers to the A/D converter on the Romar microcomputer.
- Repaired timers, heater controlled electronics, knife control switches, and defective wiring and circuit breaker on the ITEK platemaker.
- Made several repairs on darkroom equipment in the photography lab.
- Installed a remote thermostat on air conditioner in the Mass Spectrometer Room. Also repaired magnet power supply and Buckout panel on the Mass Spectrometer.

This partial list of services performed for Survey staff indicates the usefulness and versatility of our Electronic Shop. These services save the Survey thousands of dollars each year and eliminate much of the downtime staff would encounter if outside vendors were used.

Automotive

Three vehicles were acquired during this reporting year: a 1984 Chevrolet Cavalier sedan, a 1983 Oldsmobile station wagon, and a 1984 G.M.C. carryall. During this period we also requisitioned two new vehicles: a 1985 van to replace Vehicle #10 (a 1978 Dodge van), and a 1985 carryall to replace Vehicle #16 (a 1977 G.M.C. carryall).

During the reporting period, a road construction Hydra Hammer and trailer were purchased for use as a seismic thumper. Chris Wilson of the garage totally overhauled the Hydra Hammer, rebuilding the transmission, hydraulic control valves and hydraulic ram on the tower; installing new hydraulic system hoses and brake lines; and tuning the engine and rebuilding the carburator. Wilson and other shop staff completed repairs to the trailer, including installation of an electric winch, tool box, and a paint job. In addition, the trailer required brake shoes, rewiring of the electrical brake system and lights. The OMI power boat also required repairs to make it operational.

LIBRARY

Operations

The Library/Map Room provides a wide range of services to Survey staff. Journals, bibliographies, and other materials are routed to alert staff to work being done in their fields. The librarians consult with researchers on their scientific information needs; locate articles, reports, and books; verify and complete citations; borrow materials on inter-library loan; prepare bibliographies on requested topics; conduct online literature searches; instruct staff in the use of the Library/Map Room and its resources; and maintain a clippings file of relevant news articles. Library statistics show an increase in the use of library services, but a decrease in the use of in-house materials. The Library/Map Room also provides space for informal meetings of 2 to 8 people.

This year the Library began searching Illinois Research Network (IRN), an online computerized data base of research and scholarship interests of faculty at seven Illinois universities. The Library also began monitoring current Illinois legislation through the computerized Legislative Information System (LIS), based in Springfield.

A significant effort was directed to sorting and processing gift materials received as staff cleaned out their offices prior to reorganizational moves. More than 40 boxes of materials, of which 30 have been sorted and processed, were received by the Library. More than 3,000 maps and photographs were received by the Map Room from August to December, 1984. Since then another 2,000 maps and photographs have been received. Of these, the topographic maps have been sorted and processed. In addition to processing gift materials, a major effort was made to continue to reduce current cataloging backlogs. A program was developed for use on the PDP 11/34 computer to produce card sets. Although not totally automated, this program provides a reasonable means of producing catalog cards. Subsequently, more than 4,000 cards were produced and the card backlog eliminated. The cataloging backlog was also reduced.

Personnel

The Assistant to the Librarian resigned July 31. Her replacement, Rachel Friedlander, who began work December 1, has an M.S. in Library Science.

Projects

The updating of the ISGS List of Publications was assigned to the Library in mid-August. This List was last published in 1980 and has been out of print for more than two years. Initial updating and correcting has been completed, and the List is currently being tested in the ISGS Information Office. Further editing will be required prior to publication.

In mid-January, the Library was assigned the task of developing a working archive for the Fermilab SSC Project and related materials. David Montgomery, who has archival experience and an M.S. in Library Science, began work February 1. The Library designed an online system similar to the system used at Fermilab for use on the Prime 750 computer with the Terms program. More than 60 percent of the documents available in the Survey have been examined, indexed, and entered.

Library Committee

The Library Committee, reactivated after the ISGS reorganization to provide guidance to the Library, is concentrating this year establishing a collection development policy.

Other Activities

The DENR Librarians met twice to identify areas in which to increase cooperation and coordination. A joint proposal is being developed to improve resource sharing. The Librarian presented an ISGS Seminar on the U of I Library Online Catalog and its use. The Assistant Librarian, Kristi Mercer, served as State Library Chair for the National Federation of Business and Professional Women and spoke in Chicago, Springfield, and Carbondale. The Librarian also attended a microcomputer workshop in order to become more familiar with the uses of microcomputers in libraries.

Library Operating Statistics

	1984-85	1983-84	1982-83	1981-82
Acquisitions				
Total number:	2,543	4,164	4,372	3,350
Books	100	75	25	20
State documents	591	548	368	563
U.S. documents	424	647	799	654
Canada documents	135	128	201	180
Miscellaneous documents	401	234	165	279
Manuscripts	22	4	11	28
Maps	*868	623	2,748	1,609
Field notebooks	2	7	5	3
Photographs	*---	1,898	50	20
Total items withdrawn:	***	1,006	5,241	0
Serial titles and newsletters received:	246	290	331	331
Library Circulation				
Total number:	3,063	3,615	4,886	4,731
Books, documents, serials, misc.	1,820	2,218	2,944	2,678
Maps	1,087	1,193	1,687	1,429
Field notebooks	45	48	167	63
Photographs and slides	111	156	88	563
Visitors:	569	361	560	594
Interlibrary Loans				
Total number:	658	415	448	417
from University of Illinois	522	323	---	---
from Lincoln Trail Library System	136	92	---	---
Reference questions:	515	271	366	350
Online literature searches	48	70	31	14
Periodicals routed: (not counted in circulation statistics)	2,343	2,344	2,265	2,640

* Reflects only the material processed into the Map Room. There is a large backlog waiting for processing.

*** Twenty journal titles which had been discontinued for five or more years were approved and withdrawn.

EDUCATIONAL EXTENSION AND PUBLIC RELATIONS

The Educational Extension and Public Relations Unit provides information and materials on the state's geology, mineral resources, and landscape to elementary, high school, and college science teachers, as well as to interested laymen and students. In addition, the staff is available to present slide-illustrated talks concerning research and service activities of the Geological Survey to science teacher workshops, high school science classes/clubs, and citizen groups throughout the state.

Geological Science Field Trips (Reinertsen and others). Although these field trips are open to the general public, they are designed primarily to furnish teachers with background material on the geology, mineral resources, and landscape of Illinois for classroom use. A guide leaflet containing detailed descriptions of points of geological interest is prepared and distributed to the participants. Additional guide leaflets from about 85 previously held field trips are maintained on permanent file so that teachers and others may obtain them for later use. During this report period, an average of about 61 of these older guide leaflets were distributed each month.

Attendance for the four field trips held during this reporting period totaled approximately 514, compared with 470 for 1983-1984. Individual field trip attendance figures were as follows: Morris Area (May 19), 225; Pontiac-Streator Area (October 6), 115; Anna-Jonesboro Area (November 10), 90; and Salem Area (April 20), 84 (estimate).

Correspondence (Carlisle and Reinertsen). More than 475 mail inquiries were received from the general public; and answered with a letter or with publications. About half these requests were from schools, other educational groups, and libraries. More than 180 long distance telephone inquiries were resolved, many by sending publications. More than 80 individuals came to the unit office seeking information and materials.

Approximately 564 copies of the Educational Series booklets were distributed to teachers. About 21 topographic map sets accompanied by the "Guide to Use of Illinois Topographic Maps" were distributed to Illinois schools. (More than 35 additional copies of this guide were furnished to teachers.) More than 100 copies of the "Landforms of Illinois" map by James A. Bier (Department of Geography, University of Illinois) were distributed this past year.

Rock and Mineral Sets (Zelinsky, Klitzing, McKinney, Carlisle, and Reinertsen). The free set of 35 labeled rocks, minerals, and fossils distributed to Illinois schools, Scout councils, and other educational groups, is designed primarily for classroom display purposes and for aid in identifying unknown rocks brought in by students. The sets are distributed at the rate of one per school or one per 500 in enrollment. Chuck Zelinsky, Superintendent of the Geological Samples Library, supervises the assembling of these materials under the guidance of the Educa-

tional Extension and Public Relations Unit. During this report period, approximately 168 rock and mineral sets plus 5 orders for replacement specimens were distributed to Illinois institutions. In addition, some 63 coal ball slices were sent to Illinois schools.

Educational Resources (Reinertsen and Carlisle). This is the new title for the former "Geological Science Teaching Aids." A new, half-page format designed by the editorial and drafting-room staffs resulted in an attractive, useful booklet. The booklet contains lists of services and general, nontechnical publications and maps available from the Survey that are suitable for primary and secondary schools. Under the Survey's new pricing policy, Illinois schools are entitled to one free copy of any requested publication and certain maps; additional copies are billed based on the current price list. A bulk mailing of the Educational Resources booklet, totaling more than 7,300 copies, was sent to Illinois public and parochial schools and the regional superintendents this past fall. A second bulk mailing of nearly 500 copies was sent to Illinois teachers known to be teaching at least some earth science. The Educational Resources booklet has also been distributed at teachers meetings.

Educational Exhibits (Reinertsen). Educational exhibits on the geology of the state and the research and service activities of the Survey were displayed at Illinois Oil and Gas Association annual meeting (Rend Lake, June 22) and at the Illinois Science Teachers Association annual meeting (Chicago, November 2-3). Representative educational materials were assembled for display during visits of personnel from the Bureau of the Budget and the Department of Energy and Natural Resources. Assistance was furnished to other sections and groups in the Survey planning displays for these visits. The Fermilab Group's exhibit on a proposed site for 20 TeV accelerator and the geology of the region was displayed at University Inn, Champaign, at the winter meeting of the Board of Natural Resources.

Lectures (Reinertsen). Presentations were made to the following groups: Earth Science Teachers Workshop at Naperville; Workshop of the Association of Illinois Soil and Water Conservation Districts, Champaign; Robeson Grade School, Champaign; Community Group at the Illinois Valley Community College, Oglesby; Adlai Stevenson High School, Prairie View; Danville Double I Gem and Mineral Society, Champaign.

Press Relations (Staff). Four press releases concerning field trips were sent through either the Illinois Information Service, Springfield, or the University of Illinois News Bureau. Press releases concerning an award, a retirement, and a new staff member were prepared by this unit and passed along to the University of Illinois News Bureau. Material for a feature story on the Samples Library at the Annex was also given to the News Bureau. Two feature stories by News Bureau staff, one concerning glacial erratics and the other about ancient dust storms in Illinois, were reviewed by M. M. Killey and Reinertsen before being released to the press.

Other Activities (Reinertsen). The Danville Double I Gem and Mineral Society was given a special Saturday afternoon tour of Survey exhibits. A Saturday field trip was conducted for the spring meeting of the Illinois Earth Science Association (teachers) in the De Kalb area.

RECOGNITION AND SERVICE



James C. Bradbury, Emeritus Head, Mineral Resources Group (left), receives the Hal William Hardinge Award of the Society of Mining Engineers/AIME for service to the Industrial Minerals Division of the Society of Mining Engineers and for his geologic studies of fluorspar, tripoli, and carbonate rocks. Making the presentation is Gill Montgomery, long-time member and official of the Society.

RECOGNITION AND SERVICE

COMMUNICATING WITH INDUSTRY, GOVERNMENT, AND THE PUBLIC

The Illinois State Geological Survey has a long history of service to the citizens of the state as a source of scientific information and unbiased expertise. Our continuing goal is to provide sound, useful scientific information on the state's natural resources in order to promote sound economic development and a healthful environment for the benefit of all the citizens of Illinois. The ISGS provides information about the geology and mineral resources of the state by:

- publishing reports and maps that reach a wide audience
- leading field trips for the public
- providing educational resource materials for schools
- preparing special reports and giving expert testimony for governmental bodies
- talking with citizens' groups and other segments of the society about the Survey's research findings
- answering questions for radio, TV, and print media
- responding directly to telephone calls, letters, and visitors

Meeting directly with the public, with industrial representatives, and with government officials is especially helpful to the Geological Survey. Our work with the Superconducting Super Collider this year has provided numerous opportunities for contact between the Geological Survey and the public. The ability of the Geological Survey to respond quickly and effectively to the demand for detailed geological information about the 20 TeV Supercollider site has substantially enhanced our image among the many segments of society we serve.

We were especially pleased to have the opportunity this year to review our activities with Dr. Robert Mandeville, Director of the Bureau of the Budget; with John Floyd, Staff Analyst for the Bureau of the Budget; and with Dr. Don Etchison, Director of the Department of Energy and Natural Resources; Tom Pigati, Director of Administration; Assistant to the Director John Elmer; and other DENR staff who visited during this year. We also met with industry representatives this year to seek their advice as we modified the copying services provided for our Geological Records Unit; we found that we were in agreement regarding the need to protect the valuable well records and to provide maximum access to the data. Our present system responds to those needs, but we are continuing to improve the system by moving as rapidly as possible toward computerization of record searching and ordering.

What else should the Survey be doing to use its expertise to work in the best interests of the state? We hope that government, industry, and the public will continue to meet with us to help us answer that question. We are constantly seeking better ways to meet the state's needs through our geological research and dissemination of our scientific information.

HONORS AND AWARDS

James C. Bradbury, Emeritus Head, Mineral Resources Group, was named 1985 recipient of the Hal William Hardinge Award of the Society of Mining Engineers/AIME, "For service to the Industrial Minerals Division of the Society of Mining Engineers and for his geologic studies of fluorspar, tripoli and carbonate rocks."

Charles Collinson was elected an Honorary Member of the Society of Economic Paleontologists and Mineralogists.

Leon R. Follmer has been appointed Adjunct Professor of Geography and of Geology, University of Illinois at Urbana-Champaign.

David L. Gross was awarded a certificate of appreciation by the Illinois-Indiana Section of the American Institute of Professional Geologists in recognition of his years of service to the Section as newsletter editor. Dave recently "retired" from that position.

Randall E. Hughes and David L. Gross have been elected Fellows of the American Association for the Advancement of Science.

Thomas M. Johnson has received certification as Professional Geological Scientist number 6439 of the American Institute of Professional Geologists; Certified Geologist number 547 of the State of Indiana; and Registered Professional Hydrogeologist number 291 of the American Institute of Hydrology.

Vickie L. Poole has completed all requirements for the degree of Master of Science in Hydrogeology at Purdue University and will receive her degree in May 1985.

Michael L. Sargent received the Parkland College Award of Appreciation for his services in providing occasional lectures and talks for classes.

Beverly J. Seyler received the "Best of Session" award for her paper, "Role of diagenesis in the formation of stratigraphic traps in the Aux Vases of the Illinois Basin," presented in the Reservoir Characteristics session at the annual meeting of AAPG, San Antonio, TX, May 1984.

Wen-June Su received his Master of Science Degree in Civil (Geotechnical) Engineering from the University of Illinois.

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SCIENTIFIC AND EDUCATIONAL CONTRIBUTIONS

Professional Societies

Joan K. Bartz served as coordinator for paper sessions of the Illinois Junior Academy of Sciences held in May 1984.

Robert A. Bauer is Rock Mechanics Committee Chairman for the Association of Engineering Geologists North Central District. He also co-chaired the field trips for the 25th U.S. Rock Mechanics Symposium and led a field trip to an underground longwall coal mining operation for that meeting.

James W. Baxter is a corresponding member of the Sub-Commission on Carboniferous Stratigraphy (SCCS) of the International Union of Geological Sciences; corresponding member of the International Working Group on the Dinantian and Chairman of the American Mississippian Stratigraphy Research Group of the Society of Economic Paleontologists and Mineralogists.

James W. Baxter, Charles Collinson, and David L. Reinertsen have served as an ad hoc committee to oversee preparation and submission of short articles describing significant geological sites in Illinois for the Decade of North American Geology of the Geological Society of America.

Ross D. Brower serves as historian for the Midwest Groundwater Conference. He also prepared articles for "Aquanotes," the quarterly newsletter of the Illinois Water Well Association.

Richard A. Cahill analyzed coal samples by Neutron Activation methods for a Round Robin test conducted by ASTM. He also serves as a reviewer for the International Association for Great Lakes Research and for the journal, Environmental Science and Technology, of the American Chemical Society.

Keros Cartwright is an Associate Editor of the Journal of Hydrology; member of the Groundwater Committee of the American Geophysical Union; Co-Chairman of the Committee on Hydrostratigraphic Units, Geological Society of America; contributor to the Groundwater Volume for the Decade of North American Geology, Geological Society of America; member of Committee D18 (Soil and Rock), and Vice-chairman of subcommittee D18.14 (Waste Disposal on Land), and a member of Committee D34 (Waste Materials) of the American Society of Testing and Materials.

Chen-Lin Chou is co-organizer of a symposium on the Geochemistry of Coal for the 1986 North Central GSA Meeting at Kent, OH.

Mei-In (Melissa) Chou reviewed a proposed method for determination of semi-volatile organic compounds in aqueous leachates for the American Society for Testing and Materials and several other manuscripts from other sources.

Sheng-Fu (Joe) Chou provided reviews of two proposed standard practices for extraction of solid waste samples and a proposed method for determination of semi-volatile organic compounds in aqueous leachates for the American Society for Testing and Materials. He also reviewed articles for Environmental Science and Technology, a journal of the American Chemical Society.

Charles Collinson is a member of the Mississippian Stratigraphy Research Group of SEPM and of the Working Group for Sedimentary Basins of the North American Craton for the Decade of North American Geology of GSA. He has reviewed manuscripts for the Illinois Academy of Sciences and the Canadian Journal of Earth Sciences.

Heinz H. Damberger continues to serve as Secretary-Treasurer and Program Chairman of the Illinois Mining Institute. He is also chairman of the Nominating Committee of the GSA Coal Division; chairman of the Young Engineer Award Committee of the Coal Division of AIME-SME. He will be a co-author of the section on coal of Volume P-2 for the Decade of North American Geology of GSA.

Donald R. Dickerson serves on the Council of the Illinois Academy of Science and on the Board of Directors of the Illinois Junior Academy of Science. He also has reviewed several papers for Analytical Chemistry Journal, reviewed two chapters of a book on coal for a Greek publishing house, and has reviewed research proposals. He represents the ISGS in the U of I chapter of Sigma XI and serves on the Nominating Committee for the chapter. In addition to his other duties for the Junior Academy of Science, he is also Co-Chairman of the Westinghouse Science Talent Search Committee.

William G. Dixon, Jr. is Editor for the North-Central Division of the Association of Engineering Geologists and a member of the By-Laws Committee of the Illinois Groundwater Association.

Paul B. DuMontelle served as a member of the Committee on Hazardous Waste Disposal of the American Institute of Professional Geologists. The committee's position paper, "Hazardous Waste Issues and Answers," was published by the Institute in 1984. He also serves as Secretary of the Illinois Mapping Advisory Committee. He is Chairman of the Legislative Committee of the North Central District and a member of the National Editorial Committee for Short Papers of the Association of Engineering Geologists; a member of the Screening Committee of the Illinois-Indiana Section of AIPG.

Leon R. Follmer is a member of the Committee on Soil Geomorphology of the Soil Science Society of America and a member of the SSSA--Geological Society of America Interdisciplinary Committee. He serves as newsletter editor of the Illinois Soil Classifiers Association and co-hosted the recent meeting of the Illinois Quaternary Association in Champaign.

Robert H. Gilkeson serves as review editor for the journal, "Ground Water Monitoring Review."

Robert A. Griffin is a member of Committee D-34 of the American Society for Testing and Materials and attended and participated in two meetings connected with that committee. He also serves on the Conference Program Committee of the Madison Conference of Applied Research and Practice on Municipal and Industrial Waste; on the Editorial Board, Toxic and Hazardous Substances Control Section, Journal of Environment Science and Health.

David L. Gross is a member of the Commission on Genesis and Lithology of Quaternary Deposits, International Union of Quaternary Research.

Ardith K. Hansel is a member of Working Group I--Genetic classification of till and criteria for their differentiation--of the Commission on the Genesis and Lithology of Quaternary Deposits of the International Union of Quaternary Research.(INQUA).

Richard D. Harvey is Secretary of the Subcommittee on Classification of Coal (D5.18) of the Committee on Coal of the American Society of Testing and Materials and a member of the Nominating Committee of the Society for Organic Petrology.

Paul C. Heigold reviewed manuscripts for the Journals Geophysics and Groundwater, and reviewed a research proposal for the National Science Foundation.

Beverly L. Herzog reviewed manuscripts for the journals Groundwater and Journal of Hazardous Waste Research and reviewed a book for the American Water Resources Association. She also provided peer review for a research proposal.

Richard H. Howard is a member of the Geological Committee of the Illinois Geological Society.

Randall E. Hughes is a member of the Publication and Publicity Committees of the Clay Minerals Society. He wrote the review of the Society's meeting for their newsletter. The article also was submitted to Geotimes.

Russell J. Jacobson serves as Chairman of the Tri-State Committee on Correlations of the Pennsylvanian System in the Illinois Basin and as newsletter editor for the Illinois-Indiana Section of the American Institute of Professional Geologists.

Thomas M. Johnson is a member of the Editorial Review Board for "Ground Water Monitoring Review", National Water Well Association Journal.

Myrna M. Killey serves as Secretary-Treasurer of the Illinois-Indiana Section of the American Institute of Professional Geologists. She is also in charge of registration for the Midwest Friends of the Pleistocene Field Conference. At the Annual Meeting of GSA in Reno, NV, she served as a resource geologist for a field trip for local middle and high school students conducted by the GSA Committee on Women and Minorities in the Geosciences.

Dennis R. Kolata is a member of the Ordovician System Correlation Committee of the International Union of Geological Sciences.

Morris W. Leighton serves as chairman of the Institutional Advisory Board for the Center for Research on Sulfur in Coal. He is also chairman of an ad hoc committee on Low Level Radioactive Wastes, Association of American State Geologists; serves as Secretary for the Coal Advisory Committee to the ISGS; and was recently elected as Secretary-Treasurer of the Society for Illinois Scientific Surveys.

John M. Masters is a member of the Book Publishing Committee of the Society of Mining Engineers of the American Institute of Mining Engineers.

E. Donald McKay III is a member of the local organizing committee for the 1986 national meeting of the American Quaternary Association to be held in Champaign; co-leader and co-organizer for the 1987 International Quaternary Association field excursion to examine loess deposits from Peoria to Baton Rouge; representative of the Illinois AMQUA Organizing Committee to the National AMQUA Council meeting in Reno, NV.

Donald G. Mikulic organized and is chairing the session on Silurian Geology of the Great Lakes Region at the North Central Section meeting, Geological Society of America and is editing and reviewing papers for the symposium on ferruginous and calcareous oolites of the Ordovician-Silurian Boundary.

Russel A. Peppers is a member of the Atokan-Desmoinesin Working Group of the Subcommission on Carboniferous Stratigraphy of the International Union of Geological Sciences.

Phillip C. Reed serves on the Membership Committee of the Illinois Groundwater Association. He also reviewed papers for Groundwater.

David L. Reinertsen serves as editor of "Earthshine," the newsletter of the Illinois Earth Science Association. He also led a special field trip in the DeKalb area for the spring meeting of the IESA.

J. Bruno Risatti is a member of the Precambrian Paleobiology Research Group. He attended a meeting of the group at the Center for the Study of Evolution and Origin of Life at the University of California, Los Angeles, February 15-21, 1985. He also has provided peer review for journal manuscripts for the International Water Resources Association and for the INHS.

W. R. Roy reviewed manuscripts for several journals, including the Journal of Environmental Quality, Journal of Hazardous Materials and the Soil Science Society of America Journal.

Michael L. Sargent chaired the session on Stratigraphy and Computers in Geology and was co-leader for a field trip for the North Central Section, Geological Society of America, DeKalb, IL April 24-27, 1985.

Beverly Seyler is an Illinois delegate to the AAPG House of Delegates. She serves the Illinois Geological Society as Vice President. She is also editor for a supplement to "Petroleum Geology of the Illinois Basin," an update for this 1968 AAPG publication sponsored by the Illinois and Indiana-Kentucky Geological Societies.

Neil F. Shimp is Vice Chairman and member of the executive committee of Committee D-5 on Coal and Coke of the American Society for Testing and Materials. He also serves on Technical Committee 27 on Solid Fuels and the Secretariat of Task Group 14 on Trace Elements in Coal for the International Standards Organization. The Task Group prepared and submitted a Draft International Standard for Determination of Trace Elements in Coal.

Christopher J. Stohr is a member, Engineering Applications Committee, Remote Sensing Division, American Society of Photogrammetry. He chairs the University of Illinois Aerial Photography and Remote Sensing Committee and was co-chairman of the Illinois Aerial Photography and Remote Sensing Conference, April 1984. He reviewed a manuscript for the journal, "Photogrammetric Engineering and Remote Sensing."

Wen-June Su is Chairman, Student Chapter, Association of Engineering Geologists at the U of I.

Jacob Van Den Berg is the Chairman for Illinois of the AAPG Committee on the Statistics of Drilling, and the author of "Developments in the Eastern States," for AAPG. He is the Illinois Respondent for the American Petroleum Institute.

Lindell H. Van Dyke is a member of the Membership Committee of the American Association of Petroleum Geologists.

Conferences and Field Trips

Robert A. Bauer presented a lecture titled, "Fermilab SSC exploration in Illinois," at the North Central District, Association of Engineering Geologists, Chicago, March 26, 1985.

Richard C. Berg, Leon R. Follmer, Ardith K. Hansel, John P. Kempton, Myrna M. Killey, John M. Masters, E. Donald McKay III, Dennis P. McKenna, and others all are helping to organize the 1985 Friends of the Pleistocene field conference in northern Illinois.

Dwain J. Berggren presented, "A method for describing and evaluating coal mine wastes for coal recovery," at the Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation, Lexington, KY, December 2-7, 1984.

Joanna M.R. Buckentin presented talks on ISGS research on fine coal cleaning at the Illinois Mining Institute and the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984.

Keros Cartwright was keynote speaker for the symposium on "Modification of Water Quality by Development Activities and Mining Hydrogeology," sponsored by the Geological Society of Australia, Sydney. He was also an invited speaker for the Ohio State Geology Department Lecture series.

Mei-In (Melissa) Chou presented "Variation of organic matter extracted from the New Albany Shale Group (Devonian-Mississippian) in the Illinois Basin," at the 188th National Meeting of the American Chemical Society in Philadelphia. She also presented the paper, "Chemical methods for char desulfurization," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting. October 30 - November 1, 1984.

Dennis D. Coleman presented the invited paper, "Identification of natural gas from different sources," to the American Gas Association, Aquifer Storage Section meeting in Champaign; the invited paper, "Application of geochemistry to the production, storage and utilization of natural gas," at the American Association of Petroleum Geologists meeting in New Orleans; and "Integrated study of the chemical and mineralogical behavior of sulfur in coal during pyrolytic and oxidative desulfurization, preliminary results," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984.

Charles Collinson and Rodney D. Norby led a field trip for the meeting of the American Association of State Climatologists in the Chicago area, August 10, 1984.

Joan E. Crockett presented the talk, "Oil production in the Buckhorn East Oil Field in Brown County, Illinois," at the Illinois Academy of Science.

B. Brandon Curry will present the paper, "Quaternary glacial stratigraphy of the Fox River Valley, Kane County, Illinois," at the North Central Section meeting of GSA in DeKalb, April 1985.

Ilham Demir presented the paper, "Verification of Saxen's Law for a smectite membrane compacted under simulated subsurface pressures," at the American Geophysical Union Meeting in Cincinnati, OH.

Paul B. DuMontelle presented the paper, "Engineering-Geologic approach to problems of historic longwall mining sites, north-central Illinois," at the national meeting of the Association of Engineering Geologists, Boston, MA.

J. James Eidel, Thomas C. Buschbach, and Laurence L. Sloss presented the ISGS proposal for a superdeep drill hole in Illinois to the proposal workshop of Deep Observation and Sampling of Earth's Continental Crust (DOSECC), Inc. in Houston.

Leon R. Follmer presented the invited paper, "Soil--an uncertain medium for waste disposal," at the 7th Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Waste, Madison, WI, September 1984.

Joyce K. Frost presented the paper, "Radioactive sulfur tracer study of sulfur removal in the charring of Illinois coals at 650°C," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984.

Robert H. Gilkeson presented papers at the Second National Conference on Surface and Borehole Geophysical Methods in Groundwater Investigations, National Water Well Association, Fort Worth, TX, February 12-14, 1985; the spring meeting of the Illinois Groundwater Association, April 18, 1985; and the North-Central Section of Geological Society of America, DeKalb, April 25-26, 1985.

Jonathan H. Goodwin has been elected secretary of the Yellowstone-Bighorn Research Association for the 9th year.

Robert A. Griffin participated in the "Pollution to Profit," conference in Chicago, April 16-17, 1984; the Conference on Monitoring and Aquifer Restoration of the National Water Well Association, May 23-25, 1984; Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984.

David L. Gross presented the papers, "Bed material mapping for ecological research," and "Sediment accumulation in Mississippi River Pool 19," at the Long-Term Ecological Research All Scientists Meeting, Lake Itasca, MN; "Mapping of sediment in Pool 19" for the Upper Mississippi River Conservation Committee, Burlington, IA.

Keith C. Hackley presented part of the paper, "Integrated study of the chemical and mineralogical behavior of sulfur during pyrolytic and oxidative desulfurization," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984.

Ardith K. Hansel participated in a field conference on the Glacial Geology of Norway and Sweden, August 1-21, 1984; she is leading a field trip for the North Central GSA meetings in DeKalb and is an organizer and field trip leader for the Midwest Friends of the Pleistocene 32nd Annual Meeting in May 1985. She also led field conferences on Quaternary stratigraphy in northeastern Illinois and southeastern Wisconsin in July and October 1984 with D. M. Mickelson of University of Wisconsin-Madison. She will attend an SEPM short course on Glacial Sedimentary Environments at DeKalb in connection with North-Central GSA.

Richard D. Harvey chaired a technical session for the Society for Organic Petrology meeting in Reston, Virginia and presented the invited paper, "Overview of mineral matter in U.S. coals," to the Fuel Division of the American Chemical Society at the annual meeting in Philadelphia. He also presented, "Size and maceral association of sulfide grains in Illinois coals and their washed products;" and "Information system on chemistry of Illinois coals," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting in Champaign. He chaired the meetings of the ASTM Subcommittee on Classification of Coal at Norfolk, VA.

Beverly L. Herzog presented, "A comparison of Laboratory and field determined values of hydraulic conductivity at a waste disposal site," at the Madison Conference of Applied Research and Practice on Municipal and Industrial Waste. She attended the spring meeting of the American Geophysical Union, meetings of the Illinois Groundwater Association, and a conference on Low-Level Radioactive Waste Disposal of the Illinois Department of Nuclear Safety.

Randall E. Hughes presented, "Mixed-layer kaolinite/smectite and heterogeneous-swelling smectite as indexes of soil weathering intensity," at the 21st Annual Meeting of the Clay Minerals Society, October 1-3, 1984, Baton Rouge, LA; "Use of aerial photographs and vegetation patterns to predict the distribution of fine-grained quartz and kaolinite in tailing ponds," at the 1984 Symposium on Surface Mining, Hydrology, Sedimentology and Reclamation, University of Kentucky, Lexington, KY, December 2-7, 1984.

John P. Kempton presented the talk, "Geology of North Central Illinois" for a colloquium on Fermilab in December 1984. In his position as Leader of the Fermilab Task Force he is called upon fairly regularly for presentations about Fermilab to various groups.

Myrna M. Killey presented, "Landslides: an overview of the hazard in Illinois," to the Illinois-Indiana Section of the American Institute of Professional Geologists, and "The Yorkville-Wadsworth Till Member boundary in the southern sector of the Joliet Sublobe, northeastern Illinois," at the North Central Section, Geological Society of America, DeKalb. She is one of several ISGS scientists leading a field trip on the Wedron Formation for that meeting.

Dennis R. Kolata presented, "Geological feasibility of siting the proposed 20 TeV accelerator in Illinois," to the Illinois-Indiana Section of American Institute of Professional Geologists, October 6, 1984. He also presented the talk, "Life modes of cornute and mitrate carroids," at the V International Echinoderm Conference in Galway, Republic of Ireland, and the talk, "Correlation of Champlainian (Middle Ordovician) K-bentonite beds from Minnesota to Kentucky and Tennessee, at the Annual GSA Meeting in Reno.

Robert J. Krumm presented the talk, "Analysis of a slump-type landslide, southwestern Illinois," at the North Central GSA Meeting in DeKalb.

Carl W. Kruse presented, "Clean fuels from high-sulfur coal via pyrolysis technology," at the Third Conference on Acid Deposition in Chicago; "Charring of Illinois high-sulfur coal: an Illinois State Geological Survey approach to low-sulfur fuel," at the Energy Research Foundation conference in Henniker, New Hampshire; and "Five years' experience in a modified Illinois Lo-Cal home," at the Conference on Alternative Energy in the Midwest sponsored by DENR. In addition, Dr. Kruse attended the 187th National meeting of the American Chemical Society; the U.S. Department of Energy Coal Preparation Contractors' Technical Meeting; the Gordon Research Conference on Fuel Science, and a Gas Research Institute workshop.

Chao-Li (Jack) Liu attended the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting and the Annual Meeting of the Geological Society of America.

Donald K. Lumm attended meetings of the Illinois Mining Institute, the Illinois Geological Society, the Yellowstone-Bighorn Research Association and the Geological Society of America. He also attended a U.S. Bureau of Mines seminar on Mine Ventilation and Methane Control.

John M. Masters presented, "Rock types causing D-cracking in Portland cement concrete containing Illinois gravels," at the session on Field Performance and Laboratory Testing of Aggregate Material of the 64th Meeting of the Transportation Research Board, National Research Council, Washington, DC. His co-author was William Sheftick of the Illinois Department of Transportation. Mr. Masters also attended the Forum on the Geology of Industrial Minerals and the North Central Section of the Geological Society of America.

E. Donald McKay III presented, "A correlation of lower Mississippi valley loesses to the glaciated midwest," at the South Central GSA meeting in Fayetteville, AR. He also attended the field conference of the Midwest Friends of the Pleistocene; the Annual Meeting of GSA in Reno and a field trip on the Quaternary geology of the eastern Mojave region; the North Central Section meeting of GSA; and meetings of the Illinois Quaternary Association.

Jerry R. Miller attended the conference, "Managing Low-level radioactive waste in Illinois," sponsored by the Illinois Department of Nuclear Safety.

Michael V. Miller attended the 1984 Illinois Conference on Soil Conservation and Water Quality, and the North Central Section of the Geological Society of America.

W. John Nelson presented a talk on the structural geology of the Shawneetown Fault Zone to the Illinois Geological Society.

Vickie L. Poole presented, "Anomalous fresh water in basal Pennsylvanian sandstones, southwestern shelf, Illinois Basin, Perry, Jackson and Randolph Counties, Illinois," at the Indiana Water Resources Association Meeting, Bloomington, Indiana. She will present a similarly titled paper at the North Central Section meeting in DeKalb.

Philip C. Reed presented, "Comparative analysis of surface resistivity surveys and natural gamma radiation logs in Illinois," at the 2nd Annual Conference on Surface and Borehole Geophysical Methods in Groundwater Investigations, Ft. Worth, TX, February 12-14, 1985. He also attended meetings of the Illinois Groundwater Association, the Illinois Water Well Association, and the Illinois Irrigation Association.

J. Bruno Risatti presented, "Fractionation of carbon isotopes by a deep-sea hydrothermal-vent methanogen," at the Gordon Research Conference on Organic Geochemistry at Plymouth, NH.

William R. Roy presented; "Development of standardized batch adsorption procedures: experimental considerations," at the Eleventh Annual Research Symposium of the Solid and Hazardous Waste Research Division, U.S. Environmental Protection Agency, Cincinnati, OH, April 29 - May 1, 1985; Development and application of batch adsorption procedures for designing earthen landfill liners at the Seventh Annual Madison Conference of Applied Research and Practice on Municipal and Industrial Wastes, Madison, WI.

Rodney R. Ruch, Phillip J. DeMaris, Joanna M. Buckentin, and John D. Steele each presented part of the talk entitled, "Limits of removal of sulfur, chlorine and trace elements from fine coal--an aggregate flotation application," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984. Dr. Ruch also attended meetings of the American Chemical Society, the Illinois Mining Institute, and the SIU-Energy Resources Commission Acid Rain Conferences in 1984 and 1985. He also participated in the program review of the SIU Coal Extraction and Utilization Research Center.

Michael L. Sargent attended meetings of: the North-Central Division, Association of Engineering Geologists; Continental Interior Scientific Drilling Workshop, Lawrence, KS; Missouri Tectonic Atlas Project Advisory Panel, Rolla, MO. He presented: "Lithofacies and isopach mapping of the Sauk Sequence in Illinois, Omitting the Mt. Simon Sandstone and older strata," and "Map of the morphology of the top of Precambrian crystalline rocks in Illinois," at the North Central Section, Geological Society of America, DeKalb.

Howard R. Schwalb presented, "A model for tectonic deformation of the eastern stable interior crustal rocks as interpreted from overlying sediments," at the Eastern Section of the American Association of Petroleum Geologists, Pittsburgh, October 11, 1984; and "Tectonics of the Illinois Basin" at the Illinois Geological Society, September 19, 1984. He also attended meetings of the Illinois Oil and Gas Association, the Illinois Oil Producers Association, and the Eastern Oil and Gas Equipment show.

Beverly Seyler presented: "Role of diagenesis in the formation of stratigraphic traps in the Aux Vases of the Illinois Basin," at the 1984 national meeting of AAPG in San Antonio, TX; "Petroleum reservoirs in Silurian dolomite of western Illinois," at the 1985 national meeting of AAPG in New Orleans, LA; and, "Environments of deposition in the Medina Group of western New York," at the 1984 Eastern Section meeting of AAPG, Pittsburgh, PA. She also presented, "Clay mineralogy of the Aux Vases Formation," for the Indiana-Kentucky Geological Society, October 1984.

Richard H. Shiley and Randall E. Hughes presented the paper, "Desulfurization of Illinois coal by in-situ preparation of iron sulfide catalysts," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984.

Neil F. Shimp attended the annual meeting of the American Society for Testing and Materials, Norfolk, VA, May 7-10, 1984, and chaired a technical session at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984.

John D. Steele attended the 1985 Pittsburgh Conference and Exposition on Analytical Chemistry and Applied Spectroscopy, New Orleans, February 25 - March 1.

Michael D. Stephenson presented, "Low-temperature charring: oxidative desulfurization and new approaches to agglomeration," at the Illinois Coal Research Board 2nd Annual Contractors' Technical Meeting, October 30 - November 1, 1984. He also attended the American Institute of Chemical Engineers Summer Meeting, Philadelphia, PA.

Christopher J. Stohr attended the American Society of Photogrammetry 1984 Great Lakes Section and 1985 National Meetings; the Illinois Quaternary Association Meetings for 1984 and 1985; the Illinois Aerial Photography and Remote Sensing Conference; and the 10th Annual Research Symposium of the Solid and Hazardous Waste Research Division, U.S. EPA, Cincinnati, OH.

C. Brian Trask will assist Richard L. Leary of the State Museum in leading the field trip, "Early Pennsylvanian geology and paleobotany of Rock Island County, Illinois," for the North Central Section of GSA.

Teaching, Lectures, and Seminars

Robert A. Bauer presented a lecture titled, "Subsidence in Illinois and its effects on bedrock overburden," to a class at Purdue University, November 15, 1984.

Richard C. Berg presented lectures on sandy soil pedogenesis to University of Illinois classes in Soil Geomorphology and Geoarcheology, and on Environmental Mapping to a Northern Illinois University Cartography class.

Dennis D. Coleman gave three lectures on isotopic geochemistry and/or radiocarbon dating for classes from the University of Illinois and other Illinois colleges. He also made numerous shorter presentations for visitors to the radiocarbon dating laboratory.

Charles Collinson is an External Graduate Advisor for the University of Illinois Chicago and Urbana-Champaign campuses.

Leon R. Follmer helped to develop a curriculum program in Geoarcheology at the University of Illinois-Urbana-Champaign. He also presented several lectures on various topics to classes in the Geology, Geography and Agronomy Departments of UIUC and the Geology Department of UI-Chicago. He is serving as an advisor for six graduate student research projects.

Ardith K. Hansel serves as an external graduate advisor for graduate thesis research for the Geology Department, U of I.

Richard D. Harvey presented a lecture on coal petrology to a class at Indiana University and served as an external advisor for the Ph.D. committee of a candidate in the Geology Department, UIUC.

Beverly L. Herzog gave talks on Groundwater Section research and service activities for classes at SIU and UIUC. She also taught three first aid classes and four CPR classes for Survey employees.

Randall E. Hughes gave a lecture on mixed layer kaolinite/smectite and heterogeneous-swelling smectite to a University of Illinois soil science class.

Dennis R. Kolata presented the lecture, "K-bentonite of the Ordovician Decorah Subgroup, Mississippi Valley: Correlation by chemical fingerprinting," to the colloquium of the U of I Geology Department.

E. Donald McKay III presented a lecture on, "Glacial history of the midcontinent as revealed by loess deposits along the Mississippi watershed," to the Departments of Geology and Agronomy at the University of Missouri-Columbia, and a series of seminars on, "Geoarcheology and loess," for the Geoarcheology curriculum of the Departments of Geology, Geography and Anthropology at the University of Illinois.

Rodney D. Norby has reviewed the Ph.D. dissertation and is on the examination committee of a doctoral candidate at Southern Illinois University.

Russel A. Peppers presented a 2-hour lecture on coal palynology to a class in coal geology at Indiana University.

J. Bruno Risatti presented the lecture, "Carbon isotope fractionation in anaerobic sediments," to the Toxicology Laboratories Group Meeting, Harvard University School of Public Health; "Isotope geochemistry of biogenic methane: Deep-sea and near-surface sediments," at the Geology Department, Indiana University; and, "Deep-sea natural gas and origins of sedimentary methane," to the Geology Department, University of Illinois-Urbana-Champaign and Chemical Engineering Department, University of Illinois-Chicago.

Massoud Rostam-Abadi has been appointed Adjunct Professor of Chemical Engineering at Wayne State University, Detroit, MI. He is currently a thesis advisor for a Ph.D. candidate at the U of I, and a Master's candidate at Wayne State.

Christopher J. Stohr lectured on, "Engineering geology studies at a hazardous waste site," for a seminar in the Nuclear Engineering Department, U of I, February 1985. He also served as the instructor for Geography 277--Introduction to Aerial Photo Interpretation for the fall semester, on a 28% appointment at the U of I.

Janis D. Treworgy presented, "Stratigraphy and depositional environments of the Chesterian (Mississippian) Fraileys/Big Clifty and Haney Formations in the Illinois Basin" at a special colloquium of the U of I Geology Department.

Poster Sessions and Educational Exhibits

Richard C. Berg presented a poster session on Geology for Planning at the Illinois Department of Energy Annual Meeting and an exhibit on the same subject at the annual meeting of the Association of American Geographers in Washington, DC. He also presented a poster exhibit on "Potential for Groundwater Contamination" at the annual meeting of the Association of Engineering Geologists in Boston.

Ross D. Brower and Dennis P. McKenna placed and staffed exhibits about the ISGS at the Illinois Irrigation Association Meeting and the Illinois Water Well Exposition.

Richard A. Cahill gave a poster presentation at the All-Scientists meeting of the Long-Term Ecological Research Program sponsored by the National Science Foundation, Lake Itasca, MN.

David L. Reinertsen prepared and staffed exhibits for the Illinois Mining Institute; the Oil Men's Outing of the Illinois Oil and Gas Association; the Illinois Science Teachers Association annual meeting at the Museum of Science and Industry; and for the annual meeting of the Board of Natural Resources and Conservation.

Workshops/Training

Richard C. Berg helped to organize a workshop on groundwater for citizens and leaders in the Rockford area. He presented talks on "Geology of Winnebago County," and "Potential for contamination of aquifers," and helped to lead a field trip for workshop participants.

Dwain J. Berggren worked with Champaign school teachers Marilyn Sinclair and Edie Wiziecki to prepare and present an outdoor demonstration at Lake of the Woods County Park on methods to involve local geology and natural science in science, social studies, math and language arts teaching.

Stephen K. Danner served as a session chairman and assisted in organizing the Illinois Basin Coal Workshop.

Thomas M. Johnson is an invited instructor for National Water Well Association short courses in "Groundwater Pollution Corrective Actions" and "Groundwater Monitoring." One or both of these courses have been taught in eight locations across the country. Mr. Johnson also was an instructor for a University of Wisconsin Extension short course on "Groundwater Pollution Remedial Actions" taught at Madison, WI.

Latif A. Khan developed and taught a mini-course on "Recovery of coal from abandoned mined lands and effluents" during the 1984 Symposium on Surface Mining, Hydrology, Sedimentation and Reclamation at Lexington, KY.

Beverly Seyler arranged for Dresser-Atlas Company to teach a short course in well log interpretation for Survey staff and local geologists at the Survey. About 20 people attended all or part of the course over several days. Ms. Seyler also attended an AAPG school in seismic stratigraphy, November 1984.

Michael D. Stephenson attended a short course on Fluid Bed Reactor--Design, Scale-up, Problem Areas at the American Institute of Chemical Engineers Summer National Meeting, Philadelphia, PA.

Jacob Van Den Berg attended the Drilling Statistics Workshop jointly sponsored by American Association of Petroleum Geologists and American Petroleum Institute at the AAPG Annual Meeting, San Antonio, TX, May 1984.

Public Addresses

Paul B. DuMontelle presented a talk on "Earthquake Hazards in Illinois," to the American Radio Relay League District Meeting in Monticello in October.

Leon R. Follmer presented a talk on Antarctica to the Urbana Rock and Mineral Club.

David L. Gross presented talks on a variety of geology and geology-related topics to a wide range of lay groups. Topics included Geology of Lakes, the Mississippi River, a visit to the USSR and Fermilab Environmental Screening. In May 1984 he presented, "Geologic research in Illinois: Is liberal arts the best start," at the DeMott Symposium, Knox College, Galesburg.

Myrna M. Killey presented, "The Illinois State Geological Survey: Working Toward a Healthy Environment," to the Homer Historical Society; and "Landslides in Illinois?" to the Urbana Park District's program of "Sunday afternoons at the Nature Center."

Morris W. Leighton presented an address on the "Evolving Role of State Geological Surveys" at the North Central GSA Meeting in De Kalb Illinois on April 25, 1985.

Radio, TV, Press Interviews/Presentations

Heinz H. Damberger is ISGS correspondent for the bi-monthly Illinois Energy Newsletter published by the Energy Center of the University of Illinois-Chicago.

Morris W. Leighton represented the Fermilab Scientific Task Force and answered some reporters' questions at the Governor's press conference in Chicago, January 31, 1985, where the state's campaign to seek the SSC accelerator for Fermilab was announced.

C. Brian Trask and Heinz H. Damberger were featured in a news story about mapping coal resources in southern Illinois on March 26, 1985, on WSIL-TV, Harrisburg. Earlier news releases regarding previously unmapped coal resources in the Creal Springs Quadrangle generated considerable media interest.

Dennis R. Kolata was interviewed by a television news crew from the Chicago area on November 13, 1984. Dennis discussed the drilling program for the Superconducting Super Collider with scenes shot with the Fermilab building and the drilling rig in the background.

David L. Reinertsen provided a tour of the Geological Survey for W. Allen and M. Payne of the U of I News Bureau to collect material for possible use in feature articles. He also reviewed the text and provided background for two short articles prepared by the News Bureau based on Geograms 2 and 5.

Governmental Committees

Ross D. Brower serves as scientific advisor to the Illinois Environmental Protection Agency for the Underground Injection Control program. He is also a member of the Interaency Advisory Committee for the IEPA Groundwater Quality Monitoring Program. Mr. Brower also reviews county chapters for the State Water Survey Bulletin 60 Series.

Dennis D. Coleman is an advisor to the National Science Council of the Republic of China (Taiwan). He also regularly serves as a reviewer of research proposals for the National Science Foundation.

Charles Collinson serves as Vice-Chairman of the Technical Advisory Committee of the Great Lakes Commission.

Leon R. Follmer is a member of the Committee on Reclamation of Mined Land and Mine Refuse, University of Illinois College of Agriculture.

Robert A. Griffin is a member of the Science Advisory Committee of the National Center for Ground Water Research; the Grants Review Panel for Chemistry and Physics/Water Pollution and Permit Assistance Team, U.S. Environmental Protection Agency.

Richard H. Howard is a member of the Enhanced Recovery Committee of the Interstate Oil Compact Commission.

Thomas M. Johnson is a member of the Committee on Groundwater Quality Protection of the National Research Council/National Academy of Sciences.

Morris W. Leighton is a member of the Illinois Earthquake Advisory Board, Illinois Emergency Services and Disaster Agency.

David L. Reinertsen represents Director Etchison on the Statewide Advisory Board for Conservation Education of the State Board of Education. He also represents the Survey on the Statewide Advisory Committee of the Community Information and Education Service, a cooperative project of the University of Illinois and the W. K. Kellogg Foundation.

Governmental Testimony/Presentations

Robert A. Bauer provided computer programs to the Illinois Department of Mines and Minerals for use in analyzing stability of mines before issuing permits and advised DMM on some permit applications for surface mines. He also presented information on coal mine subsidence in Illinois to the Illinois Emergency Services and Disaster Agency at Vandalia, July 26, 1984.

James W. Baxter presented a talk on "Geology of Southern Illinois" to the annual aggregate seminar of the Illinois Department of Transportation, April 24, 1985.

Richard C. Berg presented talks on "Geology for Planning" to Soil Conservation Service state administrators and the La Salle County Board Planning Committee. He discussed "Potential for Aquifer Contamination" with the Northeastern Illinois Land-Use Council.

Dwain J. Berggren provided data on coal resources of Jasper and Crawford Counties for the Embarras Regional Planning and Development Commission.

Richard A. Cahill advised the Illinois EPA on procedures for sampling bottom sediments in Lake Springfield and on determination of sedimentation rates and chemical analysis. He also provided information to the National Oceanic and Atmospheric Administration for a regional summary of non-Federally funded Great Lakes Research, Development and Monitoring Activities.

Keros Cartwright was a member of the Low-Level Waste Management Options Study Group which authored: "Low-Level Radioactive Waste: Near-Term Management Options for Illinois": Illinois Commission on Atomic Energy, 1984, 80 p. He also coordinated and contributed to: Illinois Department of Energy and Natural Resources, 1984, Technical considerations relating to the siting of Regional Pollution Control Facilities: A report to the General Assembly, the Governor, and the Pollution Control Board, October 1; Illinois State Water Plan Task Force, 1984, Strategy for the protection of groundwater in Illinois: Illinois Environmental Protection Agency Special Report No. 8, 25 p.

Charles Collinson has provided extensive counsel and advice on Lake Michigan problems for numerous state, regional and local governmental bodies, citizens groups and consultants. Clients have included Illinois Department of Conservation; Illinois DOT-Division of Water Resources; U.S. Army Corps of Engineers, Chicago District; Lake County Department of Planning, Zoning and Environmental Quality; Zion Beach Park-Winthrop Harbor Marina Committee; City of Evanston; City of Lake Forest; National Oceanic and Atmospheric Administration; Illinois Nature Preserve Commission; Commonwealth-Edison Company; CENCOM, Ltd.

Donald R. Dickerson provided technical advice to the Illinois Department of Transportation regarding moisture in gasohol.

William G. Dixon, Jr. provided expert testimony for the Pollution Control Board in hearing PCB79-145.

Leon R. Follmer advised the Illinois Department of Agriculture on soils for reclamation purposes at a mine site in western Illinois.

Robert H. Gilkeson has advised the Fox Valley Water Commission on shallow groundwater resources and on radium in groundwater; the Du Page County government on shallow groundwater resources. He represents the ISGS on an interagency task force with ISWS, IEPA and U.S. Geological Survey to establish a groundwater quality monitoring network in Illinois. He also presented a talk on "Methodology for performing ground magnetic surveys at hazardous waste disposal sites," for Illinois EPA.

Robert A. Griffin advises the Illinois EPA on hazardous waste regulations and contaminant migration problems.

Paul C. Heigold advised the Illinois Emergency Services and Disaster Agency regarding earthquake preparedness and the University of Illinois Talbot Laboratory on problems from machinery associated vibration.

Beverly L. Herzog provided advice and contributed to reports about landfills and siting problems for the Governor's Task Force on the Sheffield site, for the Office of the Attorney General, for ENR, and for Illinois EPA. She is the Survey's contact for the Illinois Water Resources Network.

Nancy Peterson Holm has been working with the Center for the Great Lakes to establish an information network for Great Lakes Research. She has also provided information on Great Lakes research to the International Joint Commission, Argonne Laboratory and the League of Women Voters. She also provided information on wetlands for the State Wetlands Advisory Committee.

Morris W. Leighton represented the Governor's office in a presentation on the Superconducting Super Collider to the Illinois Congressional Delegation in Washington D.C. in September.

Dennis Kolata has been asked to assist the USGS in studying recently discovered echinoderm fauna in the Arvonian State in Virginia because of his knowledge of lower Paleozoic echinoderms.

John M. Masters supplied information on aggregate producers and natural resources to the Greater Springfield Chamber of Commerce and the Shawnee Development Council; sent a large block of St. Peter Sandstone to a U.S. Geological Survey scientist for research on pressure solution and provided information about occurrences of and panning for gold in Illinois for the Chicago office of DENR.

E. Donald McKay III prepared demonstrations of the Geographic Information System for: the Director of the Illinois Department of Nuclear Safety; representatives of the U.S. Office of Surface Mining; the National Science Foundation Long-Term Ecological Research review committee; and the Director and other representatives of Fermi National Accelerator Laboratory.

Dennis P. McKenna attended a meeting of the Rockford-Winnebago County Solid Waste Intergovernmental Committee as technical advisor and assisted in ISGS review of the consultant's report on a landfill site for the area; testified as an expert witness in a zoning case in Winnebago County and met in Rockford with Illinois EPA and state and county health department representatives to review a groundwater pollution problem in southeast Rockford, Winnebago County. He also assisted the Boone-Winnebago County Regional Office of Education in developing an educational slide show on the geology of the two counties. Classroom testing began this spring.

Donald G. Mikulic discussed geological site preservation and quarrying history along the Illinois-Michigan Canal National Heritage Corridor with the Landmarks Preservation Council of Illinois and the Upper Illinois Valley Association.

W. John Nelson presented a report on the Ste. Genevieve Fault zone at the New Madrid Study Group Reporting Session at the U.S. Nuclear Regulatory Commission, Silver Spring, MD.

Rodney D. Norby provided expert counsel to the Illinois and U.S. EPAs on the Lake Forest ravine sewer project; he also gave a talk on the geology of ravines at the Bluff and Ravine Erosion Seminar sponsored by the Lake County Department of Planning, Zoning and Environmental Quality.

Russel A. Peppers prepared a short report on biostratigraphic correlations of some coals in the Abbott Formation of Illinois and the Trade-water Formation of Kentucky at the request of the U.S. Geological Survey. The report addresses differences of opinion between ISGS and USGS about the correlations of these coals.

Vickie L. Poole compiled information on ISGS projects for an Illinois EPA data catalog of information on agencies that collect water-related data in Illinois.

Philip C. Reed gave a talk on groundwater exploration for the Harristown, Illinois, village trustees and engineers from Layne-Western Company.

J. Bruno Risatti is co-ordinator for Illinois Basin State Geological Surveys (IL, IN, KY) for a U.S. Geological Survey--State Surveys project on the petroleum geochemistry of the U.S Interior Basins.

William R. Roy provided fly ash samples and geochemical information for Argonne National Laboratory.

Rodney R. Ruch and Richard A. Cahill have been asked by the International Atomic Energy Agency to participate in a program to assist the Government of Zaire in developing methods of beneficiation the country's high-sulfur, high-ash coals. The project involves both advising on coal cleaning technology and on analytical methods for quality monitoring. The contract is being arranged through Argonne National Laboratory.

Michael L. Sargent provided borehole logging and interpretations of water wells for the cities of Aurora and Minonk. He also advised the U.S. EPA on the geology of the Mt. Simon Sandstone in northeastern Illinois in relation to possible waste disposal, and prepared and sent samples of the St. Peter Sandstone to Dr. David Houseknecht of the University of Missouri-Columbia for use in research.

Howard R. Schwalb presented information on the history and practices of Illinois oil field drilling and production to representatives of the Illinois Attorney General and other law enforcement agencies looking into irregularities in oil well promoting in Illinois. He also attended the meetings of the Interstate Oil Compact Commission in Sante Fe.

Christopher J. Stohr discussed the Eureka Dam safety investigation with the Division of Water Resources, Illinois Department of Transportation and reviewed a research proposal on Detailed Seismic Analysis of Earth Dams for DWR-IDOT. He also assisted the Illinois Comptroller's Office in processing a 3-D map of Illinois for use by bonding risk companies, and helped evaluate a new thermal infrared scanner system acquired by the Illinois Department of Corrections.

Jacob Van Den Berg prepares the Illinois portion of the annual stripper well report for the Interstate Oil Compact Commission.

Service on Industrial Committees

Robert A. Bauer presented a lecture on the Survey's Rock Mechanics Data Base to the Survey's Coal Advisory Committee, May 23, 1984.

Joyce K. Frost presented a talk on "Radioactive sulfur trace study sulfur removal in the charring of Illinois coals at 650°C," to the ISGS Coal Advisory Committee, May 23, 1984.

Richard D. Harvey presented a talk on coal classification to the ISGS Coal Advisory Committee, May 23, 1984.

Richard H. Howard is a member of the Potential Gas Committee sponsored by the American Gas Association.

Janis D. Treworgy and Heinz Damberger presented, "Coal Resources in Illinois--the new coal resource maps," to the ISGS Coal Advisory Committee, May 23, 1984.

Public Service

Mari E. Clark is president of the local chapter and area Governor of Toastmasters International.

Paul B. DuMontelle served on the Boneyard Creek Commission for the City of Urbana.

Leon R. Follmer is a member of the Environmental Advisory Commission of the City of Champaign.

David L. Gross is a member of the Board and of the Executive Committee of United Way of Champaign County; Chairman of the Board of Voluntary Action Center of Champaign County; Member of the Board and President-elect, Urbana Rotary Club.

Latif A. Khan worked on the development of conferences and workshops for the 10th Annual Conference of the Association of Muslim Scientists and Engineers, July 6-8, 1984, Lafayette, IN.

John M. Masters continues to serve as judging chairman for the Earth Science Division of the Illinois Junior Academy of Sciences. Philip C. Reed serves as vice-chairman, and many other ISGS scientists donate their time once a year as judges at the State Science Fair held in Champaign each spring.

Donald G. Mikulic gave popular talks on geology at the Urbana Free Library and the Washington Island Association.

David L. Reinertsen presented numerous popular talks to groups ranging from 2nd and 3rd grades at Robeson School, Champaign, to county extension advisers to the Double I Gem and Mineral Club of Danville. He also judged 4-H Geology exhibits at Market Place Mall, Champaign.

C. Brain Trask is a member of the Environmental Advisory Committee of the City of Champaign.

GEOLOGICAL SURVEY ACTIVITY MEASURES

Background

All Illinois state agencies are required to provide activity measures when submitting their next fiscal year's budget. The Governor's "Illinois State Budget" book also requires selected activity measures. Activity measures are helpful internal indicators of how we are doing, where our energies are going, and to what degree we may need to adjust or re-shape our program, budget, and organization. Activity measures help to indicate how the public, private, and governmental sectors may gauge our effectiveness.

Although records are kept throughout the year on such items as publications and presentations, many of our activity measures are based on results accumulated over specific sampling periods and then adjusted to an annual rate. We believe this type of limited survey provides the level of accuracy needed for this type of information. The more notable contributions of Survey personnel are to be found under the heading "Recognition and Service" in this report.

Measures

Research Activities. The ISGS had 148 state-funded projects in progress during the year with approximately an even balance among Mineral Resources, Environmental Geology, and General and Basic Research. The 86 sponsored research projects active during the reporting year constitute slightly more than one-third of all the active projects for the year. To present our research information to the public and the scientific community we produced 365 written reports, abstracts, and maps, and distributed 10,765 copies of ISGS publications, 7,003 ISGS maps, and 11,216 U.S. Geological Survey map products.

Public, Government, and Industry Services. Table 4 summarizes selected measures of our services provided during the year, as distributed by program areas.

- Information Responses: We responded to inquiries from 8,120 visitors, 7,418 letters, and 13,166 telephone calls. The Geological Records Unit (GRU) alone served 2,373 visitors and handled 75,469 files. These numbers for GRU are significantly reduced from the previous year. We believe a principal cause of this reduction is that the cost of our copying services for wireline logs has caused people to be more selective in ordering copies of files. The Geological Samples Library distributed 1,175 sample sets to 178 visitors for examination and study, and 736 more sets for study by staff members.

Illinois State Geological Survey Selected Activity Measures 1984-85

	Reports/Maps written (distributed)	Invited lectures talks and presentations	Workshops, classes, and seminars	Phone inquiries	Visitors and office conferences	Letter inquiries
Mineral Resources	126	138	14	5,530	3,628	1,159
Environmental Geology	185	259	62	5,449	1,072	1,079
General and Basic Research	48	83	15	807	927	335
Administrative Services	6 (17,768)	14	11	1,380	2,493	5,275
Grand Total	365 (17,768)	494	102	13,166	8,120	7,418

- Identifications, Analyses, and Reports/Memos. ISGS scientists completed technical analyses on more than 16,405 samples and prepared more than 800 reports/memos to present the results of those analyses. Tests performed included mineral and fossil identifications, X-ray diffraction analyses, rock strength tests, particle size analyses, and other such tests run for both research and service purposes. ISGS chemists completed 119,846 separate element determinations on 9,056 samples. In addition, our scientists completed stratigraphic logs on 28 boreholes and geophysical logs of 32 boreholes; issued 189 groundwater reports; 29 waste disposal reports; and 8 deep well disposal reports. We also investigated 101 reports of ground instability and 61 reports of mine subsidence.

Continuing Scientific/Educational Contributions. Geological Survey staff members provided 135 outside papers and abstracts and participated 170 times in various conferences and field trips. Survey staff members also presented 57 school lectures and seminars and participated in or led 45 workshops and training courses (see table). Staff members held 31 offices in various scientific or educational societies or other organizations, reviewed 55 manuscripts for scientific journals or other agencies and provided guidance for 15 graduate students. Our scientists held conferences in their offices to review and discuss scientific questions 502 times. Illinois schools received 168 rock and mineral sets from the ISGS.

Public, Industry, Government Contributions. Survey staff members presented 60 public speeches, gave 40 talks or interviews to the press, presented testimony at 17 government hearings and appeared 123 times to present information for various governmental, public, and industrial committees or other agencies. These are included in the 494 talks and other presentations listed in the table.

GEOLOGICAL SURVEY STAFF

CHIEF'S OFFICE

Morris W. Leighton, Ph.D., Chief
Jonathan H. Goodwin, Ph.D., Assistant to the Chief
Dorothy M. Spence, Secretary to the Chief
Marilyn L. Rebecca, B.A., Personnel Officer
Patricia L. Johnson, Administrative Aide

FINANCIAL OFFICE

James R. Hanner, M.B.A., Fiscal Officer
Debra A. Griest, Associate Fiscal Officer
Nona E. Neal, Account Technician II
G. Marvarine Pirtle, Account Technician I

GENERAL AND ENVIRONMENTAL GEOLOGY GROUP

Keros Cartwright, Ph.D., Principal Geologist and Head
Margie D. Eastin, Administrative Assistant
Joanne Klitzing, Correspondent II
Edna M. Yeargin, Correspondent I
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Leona M. Whitesell, Technical Assistant*
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Donald L. Graf, Ph.D., University of Illinois
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W. Hilton Johnson, Ph.D., University of Illinois
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